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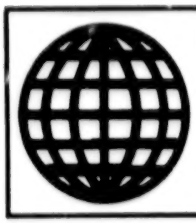

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X-ray Fluorescence Analysis of Criminal Evidence With Encapsulation of Samples in a Fusible Organic Matrix

947M0072F Moscow ZHURNAL ANALITICHESKOY KHIMII in Russian Vol 48 No 11, Nov 93 (manuscript received 30 Mar 93) pp 137-143

[Article by K.G. Shcherbakov and F.A. Gimel'farb, Moscow State University imeni M.V. Lomonosov; UDC 543.51]

[Abstract] Thanks to its nondestructive nature and speed, x-ray fluorescence analysis has gained extensive popularity in the practice of the criminal investigation subdepartments of Russia's and other countries' internal affairs agencies. Preparation of evidence samples for analysis is a critical stage in the x-ray fluorescence analysis process, and a rather large number of sample preparation methods have been developed to date. No universal sample preparation that could speed up the process of preparing samples for studies of their nature and chemical composition has yet been developed, however. One promising direction in the universalization of sample preparation is that of using a fusible organic matrix to encapsulate evidence samples. The biggest constraint of the fusible organic matrix is the fact that it could only be used with those elements that are capable of simultaneously dissolving and forming extractable compounds. In an effort to eliminate this constraint, researchers worked to develop both liquid and solid bodies and suspensions of fusible organic matrix and thereby prepare encapsulated heterogeneous radiators. Analysis-grade paraffin and stearin were used for the experiments. The samples to be analyzed were prepared in one of two ways: 1) weighted samples of study material were mixed with stearin (paraffin), placed in the radiator's holder (which was mounted on a polished surface), heated to 100°C, and cooled in air, or 2) a weighted portion of stearin (paraffin) was placed in the radiator's holder (which was mounted on a polished surface), heated to 100°C, and cooled in air, after which a weighted portion of material in liquid or suspension form was applied to the solidified hydrocarbon surface, and then melted stearin (paraffin) was poured onto it from above. The first technique was used with samples of finely ground brick, ferrous metal slag, tobacco ash, finely ground cannabis, copper powder, pieces of 0.15-mm-diameter copper wire, brass chips, and gauze tampons with traces of oil paints. The second technique was used to prepare samples of suspensions of ferrous and nonferrous metals in concentrated HCl, a suspension of pigment in concentrated H_2SO_4, a suspension of pigment in water, a 10 percent solution of $AgNO_3$ in concentrated HNO_3, and 5 percent solutions of $AuCl_3$ and $SnCl_4$ in concentrated HCl. A model XR300 spectrometer (Link Analytical, Great Britain) was then used to analysis the samples. The thickness of the absorbing layer of hydrocarbon and the size of the study object's particles were discovered to be the main factors affecting the proposed analysis method. A layer of matrix 0.25 mm thick had practically no effect on the intensity of radiations with relatively high energy (AuL_α and Ag_α). Under the same conditions, the intensity of radiation with an energy of <5 keV decreased (by 80 percent or more); nevertheless, the said radiation was also registered by the analyzer. It was thus concluded that the proposed sample preparation technique may be used with elements with $Z < 20$ and that the range of information extraction in such cases ranges from 0.25 mm for radiation with an energy of <5 keV to 3.5 mm or more for radiation with an energy of >9 keV. A minimum of 15 mg tobacco ash and a minimum of 40 mg cannabis were found to be required for analysis, and the minimum concentration of analysis object in the hydrocarbon was determined to amount to 10 percent. Further studies established that absorption of secondary radiation of samples of varying size in the organic matrix did not affect the calibration curve. Studies of samples of ground brick produced by different manufacturing plants confirmed that the method may also be used successfully to establish the origin of evidence. The new evidence encapsulation technique was thus confirmed to be quite promising and was recommended because of its simplicity, speed, and lack of any special equipment requirements. Figures 3, tables 3; references 8: 3 Russian, 5 Western.

Chemicochromatographic Determination of the Composition of a Mixture of Methylphosphonic o-Hexyl Methylphosphonic Acids and Their Anhydrides and Acid Halides

947M0072E Moscow ZHURNAL ANALITICHESKOY KHIMII in Russian Vol 48 No 11, Nov 93 (manuscript received 13 Jul 92) pp 122-130

[Article by I.N. Stankov, A.N. Beresnev, and S.N. Lanin, State Russian Organic Chemistry and Technology Institute, Moscow, and Moscow State University imeni M.V. Lomonosov; UDC 543.544:547]

[Abstract] A chemicochromatographic method was proposed for determining the composition of a mixture of organophosphoric acids and their anhydrides and acid halides. The proposed method included successive treatment of the analysis mixtures with ethylene oxide in the presence of small quantities of titanium tetrachloride, aliphatic amine, and diazoalkane to transform them into a form convenient for chromatographic analysis followed by gas chromatographic separation of the resultant derivatives. Specifically, the method called for dissolving 0.1 to 0.05 g of the mixture undergoing analysis in the appropriate solvent, adding a 50 percent solution of ethylene oxide in dioxane and two drops of a 20 percent solution of titanium chloride in toluene or tetrachloromethane, holding the mixture for 10 minutes at 20-25°C, adding 0.1 ml diethylamine, heating the mixture for 20 minutes at 80°C, and then cooling the mixture, adding 0.5 ml of ethanol or methanol, and dissolving the aliphatic diazo compound until the release of nitrogen bubbles ceases. The resulting mixture is then subjected to chromatographic analysis. Tests in which the proposed method was used along with a Tsvet-500 chromatograph with a flame ionization detector to analyze the products of a number of manufacturing processes established that the method has a maximum relative error of determining mixtures of organophosphorus acids and their anhydrides and acid chlorides that averaged 3.5 percent and does not exceed 10 percent, which is comparable with the error associated

with the gas chromatographic method. The method's reproducibility and correctness were found to be dictated by the capabilities of gas chromatography itself. Figure 1, tables 5; references 7: 6 Russian, 1 Western.

Use of Microbe Sensor To Determine the Bactericidal Activity of Organic Antiseptics

947M0072D Moscow ZHURNAL ANALITICHESKOY KHIMII in Russian Vol 48 No 11, Nov 93 (manuscript received 27 Jul 92) pp 107-110

[Article by Ye.B. Nikolskaya and A.V. Svyatovskiy, Evolutionary Physiology and Biochemistry Institute imeni I.M. Sechenov, Russian Academy of Sciences, Saint Petersburg; UDC 615.32:543.257]

[Abstract] Existing methods of detecting antibiotics, surfactants, and other organic compounds possessing bactericidal properties do not provide any basis for making judgments regarding bactericidal activity. In view of this fact, an attempt was made to develop a microbe sensor that could be used to determine the bactericidal activity of organic antiseptics. The research was conducted from the initial premise that not only the properties of enzyme systems but also the change in conduction or even the integrity of the cell membrane itself could be used in a microbe sensor to detect a bactericide. The proposed microbe sensor was an electrochemical device based on a solid-contact potassium-selective electrode and *Escherichia coli* and *Bacillus subtilis* microorganisms immobilized in a covalently bound agar membrane. The agar membrane was either pressed to the surface of an ion-selective electrode by a special cap or placed into the test solution in a special device in the form of two rings, one of which was tightly inserted into the other so as to clamp the edge of a kapron mesh with the microbial membrane between them. A magnet for the magnetic stirrer rotating the membrane in the solution was also attached to the mesh. In some cases, a suspension of microorganisms was placed directly (without immobilization) into the study solution for comparison's sake. The agar membrane was prepared by treating agar gel with a 6 percent solution of glutaraldehyde, carefully rinsing the excess glutaraldehyde from the covalently bound agar membrane, and placing it in a solution of 2-3 billion microbial cells/ml for a day at 37°C so that the agar could become overgrown with microflora that was thereby fixed in the nutrient medium. The membrane measured 1 mm in thickness, and its diameter corresponded to that of the potassium electrode (6 mm). The ion-selective potassium electrode was calibrated in accordance with KCl comparison solutions with concentrations ranging from 1 to 10 mmol/l. The microbe sensor was calibrated by the method of standard addition of KCl solution. The membrane with the microflora and electrode with the membrane were balanced in a solution containing 100-144 mmol/l NaCl and 1.5-3 mmol/l KCl. To study the bactericidic properties of the test materials, researchers added heavy metal salts ($CuSO_4$, $NiCl_2$, $Cd(NO_3)_2$, $HgCl_2$) and several antiseptics to the sample along with healthy pig blood serum with a bactericidal activity of 93-100 percent. The microbe sensor developed was based on the principle of registration of the change in concentration of potassium ions on the sensitive surface of a potassium-selective electrode that occurs as microbial cells die or multiply. Comparative tests of the three microbe sensor designs established the following: using immobilized microflora increases the electrode's response time severalfold; the least amounts of study solution may be used in the case where the microflora is immobilized in a special device in the study solution; and the design in which the membrane with the immobilized microflora is pressed to the electrode's surface permits partial or total elimination of the effect of the bactericide on the potassium electrode's active membrane. Several qualitative differences between the effects of organic and inorganic antimicrobials were identified and discussed. Studies performed with the electrode system also confirmed that the microbial membrane can be reactivated after having been subjected to the effect of bactericides. Figures 3; references 5 (Russian).

Flowthrough-Injection Analysis. Spectrophotometric Detection of Ammonium and Hydrocarbonate Atoms in Atmospheric Precipitation

947M0072C Moscow ZHURNAL ANALITICHESKOY KHIMII in Russian Vol 48 No 11, Nov 93 (manuscript received 5 May 92) pp 35-42

[Article by I.D. Yeremina, L.K. Shpigun, and Yu.A. Zolotov, Moscow State University imeni M.V. Lomonosov, and General and Inorganic Chemistry Institute imeni N.S. Kurnakov, Russian Academy of Sciences, Moscow; UDC 543.422.002.5:546.171.1:546.264]

[Abstract] A study was undertaken to create highly sensitive methods of spectrophotometric detection of ammonium and hydrocarbonate ions in atmospheric precipitation in a flowthrough-injection system with gas diffusion based on comparative study and selection of available sensitive acid-base indicators. An FIAstar-5020 (Tesator, Sweden) microprocessor-controlled flowthrough-injection analyzer with an FIA-5023 spectrophotometer and flowthrough cell was used in the studies. The flowthrough-injection circuit was mounted on a Chemifold V flow distributor with a "sandwich"-type gas diffusion cell (the flowthrough channel measured 75 x 2 mm and 0.2 mm in depth). Porous Teflon film with a thickness of 0.01 mm (manufactured by Tesator) was used as a membrane. The starting indicator solutions (0.1 percent) were prepared by dissolving an exactly weighed sample (100 mg) in 100 ml of twice-distilled water or in 50 percent ethanol. The starting solutions were diluted 20x by adding alkali or acid in drops to create a pH within the range of the given indicator's color change range. The starting ammonium ion solution (500 mg/l NH_4^+) was prepared by dissolving ammonium chloride (0.7417 g) dried at 105°C in 500 ml of twice-distilled water, and the starting solution of hydrocarbonate ions (1,000 ml/l HCO_3) was prepared by dissolving a weighed sample of sodium hydrocarbonate (0.6886 g) in 500 ml of twice-distilled water. Comparison solutions were prepared daily by subsequent dilution of the starting solutions. Of the seven pH indicators tested, phenol red was found be most sensitive for determination of ammonium ions and bromocresol purple was found to be most sensitive for determination of hydrogen carbonate ions. The calibration graphs for NH_4^+ proved to be linear within

a range of 0.1 to 5.0 mg/l, and a lower detection threshold of 0.05 mg/l was determined. The range of determinable amounts of hydrocarbonate ions was found to be 0.5 to 20 mg/l HCO_3). The relative standard deviation found in the determination of 1 mg/l NH_4^+ and 1 mg/l HCO_3 equaled 0.01-0.02 and 0.02-0.03, respectively. In both cases, 80-90, 200-µl samples could be analyzed per hour. Figures 2; tables 4; references 12: 6 Russian, 6 Western.

Two-Step Detection of Analytical Signals in X-Ray Spectral Analysis Given an Unknown Background Intensity

947M0072B Moscow ZHURNAL ANALITICHESKOY KHIMII in Russian Vol 48 No 11, Nov 93 (manuscript received 9 Jul 92) pp 26-34

[Article by G.M. Bashin and A.T. Savichev, Lithosphere Institute, Russian Academy of Sciences, Moscow; UDC 519.29/24:543.42]

[Abstract] Interest in digital methods of processing analytic signals has been increasing because of the need to automate observations. The possibility of detecting traces of chemical elements is generally limited by the loss of visual images of analytic signals and by the observer's subjective capabilities. Commonly used methods of improving the detection and measurement of analytic signals, such as linear and nonlinear filtration and smoothing based on the least squares method, not only fail to solve the problem of detecting traces of chemical elements in study objects (qualitative analysis) and detecting differences in the study objects' chemical composition (signature analysis) but may also significantly reduce the input analytic information. In view of these potential problems, a study was undertaken to develop a series of tests of different hypotheses and alternatives corresponding to the problems of qualitative and signature analysis of x-ray spectrometry data obtained at an unknown background intensity. Tests were sought that would maintain stability with respect to unknown or nonstationary observation conditions, not use a priori information about models of spectra of characteristic x-radiation, and guarantee a constant controlled probability of false detection of analytic signals. The study began with a theoretical analysis of multidimensional discrete distributions of x-ray spectra. A series of two-step tests for qualitative and signature analysis were then developed. The first step involved qualitative or signature analysis of individual analytic signals, and the second step entailed final selection between hypothesis and alternative. Next, the threshold constants of the two tests developed were determined, and the power of the proposed tests was considered. The effectiveness of the proposed tests was examined by way of the example of a qualitative analysis of an aqueous solution of potassium iodide by means of a TEFA-III spectrometer with a low-temperature semiconductor Si(Li) x-radiation detector. The detector had a resolution of 165 eV on the Mn line (5.9 keV). The effectiveness of qualitative analysis of potassium traces was estimated in the concentration range from 0.0 to 0.5 percent after each 0.05 percent by using 50 runs of the analyzed spectrum of the aqueous potassium iodide solution and 50 runs of a "dummy" spectrum of water at each point. The probability of detection of potassium traces (β) equaled 0.994 with a potassium iodide concentration (c_{KI}) of 0.15 percent, $\tau_{analysis\ object}$ = 100 s, and $\tau_{dummy\ object}$ = 250 s. Higher potassium concentrations with c_{KI} = 0.25 percent resulted in a detection probability of β = 0.0992 by $\tau_{analysis\ object}$ = $\tau_{dummy\ object}$ = 50 s. As the number of spectrometer channels was increased to N_{init}/N_{end} = 322/340 with c_{KI} = 0.40 percent, potassium traces were detected with a probability of β = 0.92 when $\tau_{analysis\ object}$ = $\tau_{dummy\ object}$ = 100 s. The proposed tests were thus deemed suitable for use in automatic detection of traces of chemical elements during mass analyses and in commercial processes. The tests were also recommended for use in ranking objects with chemical compositions that differ only very slightly from one another. Figures 2; references 8: 7 Russian, 1 Western.

Computer Simulation and Pattern Recognition for Organic Reagents

947M0072A Moscow ZHURNAL ANALITICHESKOY KHIMII in Russian Vol 48 No 11, Nov 93 (manuscript received 6 Apr 92) pp 6-15

[Article by A.I. Zubenko, Kiev University imeni T.G. Shevchenko; UDC 541.8:543.001:519.2]

[Abstract] Most systems proposed to date for classifying organic reagents are purely qualitative and are based on such features of organic reagents as presence in the molecule of a specific functional-analytic grouping, membership in a specific class of organic compounds, structure and nature of reaction products, type of donor atoms, or size of the chelate cycle. Interest has been expressed in exploring the possibility of developing a quantitative approach to classifying organic reagents based on some set of molecular parameters referred to as descriptors that, on the one hand, characterize molecular structure sufficiently completely and, on the other hand, may be obtained for any molecule. Because the number of molecular parameters is infinitely great and because even limited attempts to explore a quantitative approach to classifying organic reagents would necessitate working with extremely large data sets, a study was undertaken to find a way of automating the classification of a number of organic reagents by using methods based on pattern recognition theory. Three groups of theoretically calculated parameters were considered: topological indexes, geometric parameters, and electron parameters. Topological indexes were dictated by molecular formula and order of atom binding, geometric parameters included such geometric factors as bond length and valence angle, and electron parameters were those parameters characterizing the distribution of electrons in an organic reagent's structure. A total of 46 different types of sulfur-containing organic reagents were used, including derivatives of dithiocarbamic acid, 1,1-dithiols, 1,2-dithiols, and derivatives of dithiophosphoric acid. Eleven parameters (seven topological indices, three electronic parameters, and one geometric parameter) were calculated for each molecule. The data were represented in the form of an $N*M$ matrix, where N represents the number of molecules and M represents the number of parameters. Each matrix element therefore represented the parameter m for the molecule n. To eliminate the effect of differences in the dimensionality, nature, and scale of the

input data, the latter were normalized. The normalized data had a zero mean and variance equal to 1. The method of hierarchical cluster analysis and the method of main components were selected as pattern recognition methods. The software used for the statistical calculations was compiled on the basis of programs from the International Mathematics and Statistics Library. The analysis confirmed that pattern recognition methods are extremely effective as a way of automating the classification of organic reagents and identifying groups of similar compounds. The analysis further established that within the framework of such groups, different correlations of the structure-property type must be strictly obeyed. The topological, geometric, and electron descriptors considered in the study proved adequate as a means of classifying organic reagents. Figures 4, tables 2; references 10: 8 Russian, 2 Western.

CHEMICAL INDUSTRY

Tomography Center Creates New Materials

947M0069A Moscow ROSSIYSKIYE VESTI in Russian 2 Jun 94 p 6

[Article by Andrey Illarionov]

[Text] This small scientific complex is officially known as the International Tomographic Center. However, four years after it started operation, this title is somewhat obsolete, in my view. During this time the research profile expanded and, in addition to the medical tasks of early diagnosis of dangerous illnesses and scientific endeavors directed toward perfecting methods and means of tomographic research, a large part of the scientific personnel is studying the micro-nature of chemical reactions and the possibility of developing new materials and other no less pressing problems.

However, possibly the most improbable fact here is that a scientific complex such as this was acquired in these difficult times by the Siberian Branch of the Russian Academy of Sciences without any significant expenditures.

It all started five years ago under the initiative of Corresponding Member RAN Renad Sagdeyev (who is, incidently, the brother of well-known Academician Roald Sagdeyev, former director of the Institute of Space Research). Renad is a specialist in physical chemistry, particularly chemical spectroscopy, a method having enormous possibilities. He is one of the discoverers of the magnetic isotopic effect. And from this comes yet another magnetism - the attraction of people to a natural born leader.

However, he is not striving for supervisory heights and today manages only a group of fifty scientists. In his view, it is just this type of small close-knit group that lends itself to fruitful research.

When I asked Sagdeyev how his dream of building a "small institute" became a reality, he expressed concern that this will be very difficult to repeat owing to its unique nature. But he nevertheless agreed to explain it.

Six years ago at the Institute of Physical Chemistry he heard a presentation by a foreign member of the Russian Academy of Sciences, a physicist from the FRG, Gyunter Laukin, an outstanding researcher in the structure of matter and creator of underwater laboratories for petroleum prospecting. Because their scientific interests crossed at many points, Renad wanted to share his thoughts with this veteran of European science and was allotted five minutes of time. However, the plans of the young scientist so interested the veteran that the conversation dragged on.

Here it must be stated that Laukin was one of the leaders of the world's largest suppliers of scientific instruments and equipment, the Brucker company (which in diversifying its basic production line, decided to venture into putting out the highest class of medical tomographs operating on the principle of nuclear magnetic resonance, of which Laukin was a supporter).

The meeting resulted in the creation of the International Tomographic Center, a joint venture with the Brucker company and an allocation and advance of one million dollars towards construction. Incidently, this was by gentlemen's agreement.

"Are scientists and businessmen abroad really so trusting?", I asked.

"Mostly it's the other way around," answered Sagdeyev, "but you have to know how to be convincing".

If the construction were carried out by the previous methods in Russia, probably there would still be no tomographic center in Akademgorodok. Hence Sagdeyev, without relying on the professional suppliers and contractors, assumed this role himself, especially since only he could imagine just what this complex should be like.

Today, the tomographic center employs over 10,000 Siberians. The service pay here is much less than that in the USA or Europe, and it does not fully meet expenses. Under agreement with the Brucker company, the most reliable contrasting substances are studied here which facilitate detection of malignant tumors and embryos. Developments in measurement of blood flow rate through vessels are also conducted here.

Interesting results were also obtained at the center on the effects of the magnetic field on the rate of chemical reactions. Previously unknown ferromagnetic materials which appear promising for use in new areas of technology were developed here.

All of this research was conducted at such a high level that Columbia University, the Free University of West Berlin, and other highly authoritative scientific organizations of the world participated in the financing.

Incidently, the scientific workers are mostly young and work under contract which may be binding, but also introduces a somewhat temporary character.

If, on arriving in Akademgorodok, you happen to be in the vicinity of the monument to M. A. Lavrenty, anyone will tell you how in three minutes of easy walking you can get to the tomographic center. A pair of buildings departing from the architectural standards of a typical Akademgorodok institute will come before you. And the difference lies

not only in a smaller size, but also in creature comforts which are so lacking to all of us today.

But the experiment of Renad Sagdeyev in creating a unique small research center is, I think repeatable in essence: the main point being that during the most difficult time there are no hopeless situations.

Composition and Properties of Black Coatings Formed During Chemical Oxidation of Metals in Solutions

947M0073B Minsk VESTSI AKADEMII NAVUK BELARUSI. SERRYA KHIMICHNUK NAVUK in Russian No 4, Oct-Dec 93 (manuscript received 16 Oct 92) pp 91-97

[Article by T. N. Vorobyeva, L. I. Stepanova, O. G. Purovskaya and V. A. Rukhlya, Physical Chemical Problems SRI, Belarus State University; UDC669.24: 669.38+621.79]

[Abstract] Chemical oxidation of metallic foils in solutions is widely used to tint and tone metal surfaces for decorative purposes as well as to impart other special functional properties such as optical, thermo-physical, and electrophysical barriers. Of especial interest is the use of the oxidation reaction to obtain coatings having a high degree of blackness, where $\varepsilon \geq 0.96$. These coatings provide maximum absorption of solar radiation in the visible and near infra-red region and may be used not only as a substitute for "black chromium" obtained electrochemically, but also as solar energy collectors or radiation detectors. In the present work copper and nickel surfaces were treated in solutions containing an oxidizer and an oxo-compound solvent to obtain black coatings having a high degree of blackness, viz. $\varepsilon = 0.96$-0.98. Optical density under reflected light was 2.25-2.40. It was demonstrated that ε is a function of the thickness of the initial metal foil, component concentrations in the oxidizing solution, temperature, and duration of treatment. In the case of nickel blackening, ε also depends on the conditions of its preparation. Coatings, obtained by oxidizing foils of Ni-P alloys, conduct electricity, while copper coatings are nonconductive. The coatings with a high degree of blackness are corrosion resistant, and the mother-black surface remains stable when the velvety black deposit is scrubbed off. Figures 3; references 10: 5 Russian, 5 Western.

Alkylation of o-Xylene With Ter-Butanol Over Zeolite and Zeolite-Containing Catalysts

947M0074A Moscow NEFTEKHIMIYA in Russian Vol 34, No 1, Jan-Feb 94 (manuscript received 20 Oct 93) pp 42-51

[Article by Ya. I. Isakov, Kh. M. Minachev, V. P. Kalinin, and T. A. Isakova, Organic Chemistry Institute imeni N. D. Zelinskiy, Moscow; UDC541.128.13:66.095.253: 547.534.2:547.264]

[Abstract] 1,2-Dimethyl-ter-butylbenzene is a starting material for the preparation of high quality phthalocyanine dyestuffs, plasticizers, photo-materials, and other valuable products. The development of a productive and ecologically safe method for the synthesis of this substance would be of great practical interest. On the other hand, conversion of the o-xylene-ter-butanol mixture for this purpose would also serve as a convenient model for studying several aspects of the fundamental problem of the selectivity of solid catalysts which could have a special bearing on the need to develop resource-saving technologies for the production of chemical products. In the present work the alkylation of o-xylene with ter-butanol was used to obtain new data on the possibility of controlling the selectivity and stability of zeolite catalysts, as well as controlling their acidic and hydrophobic properties. Studied were the special features of the action of crystalline alumina-silicates, amorphous aluminum silicate, and the zeolite-containing catalyst Zeocarb-2 in conversion of the above xylene-butanol mixture. A catalyst was developed which is capable of preparing 1,2-dimethyl-4-ter-butylbenzene in yields up to 94 percent and which may be used in a highly productive and ecologically safe method for the synthesis of this substance as a starting material for the production of several other new technologically valuable products. References 15: 7 Russian, 8 Western.

MISCELLANEOUS

Ion Chromatographic Detection of Phosphorus in Organic Compounds

947M0070A Moscow ZHURNAL ANALITICHESKOY KHIMII in Russian Vol 49 No 3, Mar 94 (manuscript received 30 Sep 92) pp 302-306

[Article by G.G. Ivanova, A.A. Ivanov, and A.N. Kashin, Moscow State University imeni M.V. Lomonosov; UDC 543.544.6:545.8]

[Abstract] A method has been developed for ion chromatographic detection of organic phosphorus compounds that have been mineralized with sulfuric acid in a Kjeldahl flask. Weighted samples (0.5 to 2 mg) of material were heated with concentrated H_2SO_4 (1 ml) at 300°C for 40 minutes, after which 2 to 4 drops of $HClO_4$ was added to each sample. The contents of the Kjeldahl flasks were then cooled and transferred into 100-ml measuring flasks repeatedly rinsed with water. The flasks were then filled to the mark, and orthophosphate was determined by a two-column version of ion chromatography on a Tsvet-3006 ion chromatograph equipped with a BAD-35 automatic metering device and columns made of Kh18N10T stainless steel. Phosphate was detected in model solutions prepared by dissolving analysis-grade potassium dihydrophosphate on the sorbents KhIKS, OKA, and ANIYeKS with carbonate eluents. A lower detection threshold of 0.1 μg/ml was achieved. When the samples were concentrated by using the BAD-35 unit, a lower detection threshold of 0.001 μg/ml was achieved. The new organic phosphorus compound detection method was tested with real solutions containing large amounts of sulfate and perchlorate and smaller amounts of nitrate and chloride, which are always present as impurities in the acids used and which may also form upon the decomposition of the organic matter undergoing analysis. In the said tests, lower detection thresholds of 1 to 5 μg/ml were achieved depending on the type of sorbent used in the separation column. The phosphate

detection threshold could not be lowered by concentrating the sample because of the increase in the interfering effect of the real solutions' aforesaid impurities as samples are concentrated. The interfering effect of nitrate in the samples analyzed was reduced when ANIYeKS was used instead of KhIKS. The phosphate detection threshold was significantly lowered when the effect of sulfate on anion separation was eliminated. Removing the sulfate present in the samples in large quantities had the added benefit of reducing corrosion of the columns and lines and reducing cumulative contamination of the sorbent to the point where it would have to be replaced after 18-20 hours of continuous use. Nitrate, arsenate, germanate, silicate, iron, tin, and palladium did not interfere with the detection of phosphorus. Simultaneous determination of phosphate, fluoride, and chloride was shown to be possible. Figures 5, table 1; references 16: 5 Russian, 11 Western.

Seminar on Biochemical Detection of Pesticides

947M0071A Moscow ZHURNAL ANALITICHESKOY KHIMII in Russian Vol 49 No 3, Mar 94 pp 334-336

[Article by I.V. Karandi and M.M. Buzlanova under the "At the Russian Academy of Sciences Scientific Council on Analytical Chemistry" rubric: "Moscow Seminar on Organic Analysis"]

[Text] Biochemical methods of detecting pesticides were considered at the session held on 21 April 1993. Ye.B. Nikolskaya (Saint Petersburg) and G.A. Yevtyugin (Kazan) presented the paper "Enzyme Method of Using Cholinesterase To Detect Pesticides." The use of cholinesterase to detect pesticides is based on the inhibition of this enzyme's catalytic activity by selected pesticides. The active center of cholinesterase, whose serine forms a covalent bond with part of the pesticide's molecule, is the target of organophosphorus and carbamate pesticides (amidophos, Baytex, dichlorvos [DDVP], metaphos [methyl parathion], Korlan, fozalin [transliteration], Baygon, Sevin, etc.). The activity of these substances is highly selective, which makes it possible to detect microquantities of them at the maximum permissible concentration [MPC] level or lower. Organochlorine compounds or derivatives of quarternary ammonium bases (zefiran [transliteration], retatsel [transliteration], broal [transliteration], etc.) react with cholinesterase in a reversible manner, and their detection thresholds are generally high. Both very simple visual methods and automatic instruments operating in a continuous mode are used in detecting pesticides. Electrochemical, colorimetric, and fluorimetric enzyme sensors have come to be widely used in detecting pesticides.

The report presented by B.B. Dzantiyev (Moscow) was devoted to the possibility of using an immunoenzyme assay in solving the problems of quantitative determination of pesticides. Solid-phase, homogeneous, and membrane methods of immunoenzyme detection of pesticides with various compositions, structures, and properties have been developed at the Immunobiochemistry Laboratory of the Biochemistry Institute imeni Bakh of the Russian Academy of Sciences. Included among them are organophosphorus (the Malathion insecticides karbofos and metaphos), organochlorine (2,4-dichlorophenoxyacetic acid, 2-methyl-4-chlorophenoxyacetic acid, etc.), and nitrogen-containing pesticides (Simazine and Atrazine). Solid-phase methods based on the use of immobilized antibodies and pesticides labeled with a peroxidase enzyme make it possible to detect pesticides in concentrations of 1 to 5 ng/ml in an analysis time of 2-3 hours. Homogeneous methods are based on the effect of antibody modulation of enzyme activity and are characterized by lower sensitivity and higher speed. The herbicide 2,4-D, for example, may be detected with a sensitivity of 2 μg/ml in 30 minutes. Membrane immunoenzyme assay methods make it possible to detect pesticides with visual detection and do not require special equipment. They are based on the use of synthetic water-soluble electrolytes capable of instantaneous formation of insoluble polyelectrolyte complexes. The methods that have been developed are promising for use in medicine and agriculture and for solving problems of environmental protection (testing the amount of pesticides in water, air, soil, and foodstuffs and diagnosing pesticide poisoning).

The report by S.A. Yeremin (Moscow) "Quick Detection of Pesticides by the Method of Polarized Fluorescent Immunoassay" was heard next. Methods based on immunochemical reactions such as immunoenzyme assay or polarized fluorescent immunoassay are being used successfully in detecting pesticides in foodstuffs, soil, humans' and animals' bodies, and drinking water. The polarized fluorescent immunoassay method involves competition between the substance being detected and a substance labeled with a fluorescent tag to bind with specific antibodies. The polarization of the fluorescence of the fluorescein-labeled substance increases in the process. The polarized fluorescent immunoassay method is simple and entails adding an aliquot of the sample and a fluorescein-labeled substance to a solution of antibody and then measuring the polarization of the fluorescence and determining the concentration of substance in the sample. The higher the concentration of substance in the sample, the lower the polarization of the reaction mixture's fluorescence. The author has developed quick methods of polarized fluorescent immunoassay to detect a number of familiar pesticides (karbofos, 2,4-D, 2,4,5-T, Simazine, Diatrazine, etc.). Specific polyclonal and monoclonal antibodies have been obtained for this, and fluorescein-labeled pesticides with different chemical structures of the "bridge" connecting them have been synthesized. By altering the chemical structure of this bridge, it is possible to alter the specificity and selectivity of polarized fluorescent immunoassay of pesticides while using one and the same antibodies. Polarized fluorescent immunoassay methods have been developed that make it possible to detect pesticides in concentrations from 0 to 100 μg/ml with a detection time of 1 minute, sample volume of 50 μl, and lower detection threshold of 10-1,000 ng/ml.

At the session held on 19 May 1993, A.M. Tsukerman spoke about the international exhibition Ekologiya-93 that was held in Moscow in April.

The report "Modern Approaches to Analysis Based on the Use of Surfactants" by S.N. Shtykov (Saratov) was heard next. Presented in the report was a new physicochemical approach that makes it possible to improve the effectiveness of methods of analyzing, isolating, and concentrating

organic compounds without additional expansion and complication of the instrument base of analytical methods. The approach is based on the use of what are termed "organized" systems (media) facilitating maximum use of the possibilities of the electron structure, geometry, and chemical properties of reactant and the properties of the reaction medium. A classification of such systems was represented that makes it possible to identify self-organizing (synergic) systems, rigid monomolecular structurally organized systems, and mixed-type systems. Examples of organized systems (forward and back micelles of surfactants, microemulsions, vesicles, liposomes, biolayers, cyclodextrins, cyclophanes, etc.) were given, and the areas of their use in analysis were briefly considered. Detailed information was presented regarding the properties and structures of the surfactants and cyclodextrins that have become used most extensively. It was demonstrated that most research studies are related to the use of organized systems in photometric, luminescent, and chromatographic analysis methods. Their use in spectroscopic methods has resulted in an improvement in the sensitivity and selectivity of detection, a 1- to 2-order of magnitude reduction in the detection thresholds of organic compounds, an increase in quantum yields of luminescence and precision of detection, and a decrease in the time spent on sample preparation and analysis. A new analysis method has been created in spectroscopy, namely, phosphorescence at room temperature in solutions of surfactants and cyclodextrins. The use of surfactants in extraction has made it possible to propose a new method, i.e., micellar extraction, that is based on the concentration and isolation of a substance in a micellar phase. In chromatography, surfactants and cyclodextrin are used as components of both mobile and immobile phases. New techniques and methods have been created such as micellar chromatography and micellar electrokinetic chromatography. The use of such factors as size of the molecule being determined, size of the cyclodextrin's cavity or nature of the surfactant's micelle, hydrophobicity, and charge of the molecule being determined has made it possible to isolate homologues and place isomers and geometric isomers, enanthiomers, molecules with identical size but differing charge hydrophobicity, etc. Also considered in the report were theoretical works of the Analytical Chemistry Department of Saratov State University, in which factors were uncovered that determine the properties and effectiveness of micelles of surfactants and practical results that have been obtained in the photometry, extraction, and thin-layer chromatography of organic compounds.

The session held on 16 June 1993 was devoted to detecting organic carbon. S.V. Lyutsarev (Moscow) presented the report "Detecting Organic Carbon in Sea and Fresh Waters, Soils, and Rock. The Experience of Using the Proposed method and Instrument in Studying the World Ocean." The presenter demonstrated the AUL carbon analyzer, which he created. The instrument is intended for detecting absolute total concentrations of solid, truly soluble, colloidal, and emulsified organic substances, including pollution of anthropogenic origin (petroleum, industrial, and municipal sewage) while monitoring the environment, conducting expert arbitration examinations, etc. The absolute content of organic or inorganic carbon in liquid and solid samples is determined semiautomatically on the basis of the wet decomposition and oxidation of the sample in a medium of a concentrated sulfur and chromium mixture at 130°C. The gaseous CO_2 formed by the stream of carrier gas (air) is transferred from the reactor to a coulometric cell. The amount of CO_2 is determined automatically by using an exact absolute (without calibration based on standard specimens) method of coulometric acid-base titration with a constant current. The analysis results are indicated on a light-emitting diode display and are recorded on a small graph plotter. Among the method's advantages are the availability and low cost of steel electrodes and its use of the principle of a closed cycle, which eliminates errors due to incomplete oxidation of the decomposition products. The method has a measurement range of 3 to 1,500 µg carbon in a sample for solid materials and 0.5 to 300 mg carbon/l for solutions, a measurement error of 3 percent given a concentration of 10 mg carbon/l (150 µg carbon in a sample) and 5 percent given a concentration of 2 mg carbon/l (30 µg carbon in a sample), and a measurement time of 90 minutes (with the elimination of inorganic carbon). The instrument is transportable and has a modular design that includes a reactor unit for breaking down the sample, an automation equipment unit, and a graph plotter. The instrument's small size and high reliability make it usable not only at stationary plant and research laboratories but also under the stringent conditions of field geological parties and marine expeditions. During the course of the discussion, the seminar participants expressed the opinion that the presence of a reliable, highly sensitive, and informative method that does not require standardization and that is embodied in an easy-to-operate portable instrument makes it possible to discuss the issue of including indicators of organic carbon content along with or instead of chemical oxygen demand [COD] among the normed indicators for water.

B.K. Zuyev (Moscow) presented a communication about an absolute method of determining the oxidizability of organic matter that was developed at the GYeOKhI of the Russian Academy of Sciences. The method is based on determining the amount of oxygen used for combustion of the organic matter in a sample. A coulometric solid-electric cell with oxygen conduction is used to determine the amount of oxygen. Using the cell made it possible to create an absolute method of determining the oxidizability of organic matter, which is important in determining the cumulative characteristics of water with an unknown organic pollutant profile. The unit developed on the basis of the proposed method makes it possible to analyze water with an oxidizability ranging from 10 to 1,000 mg/l in 5 to 10 minutes with a measurement error not exceeding 2 percent. Also presented was a method based on the high adsorbability of a platinum electrode, which was in turn used at the GYeOKhI of the Russian Academy of Sciences as a basis for creating a small electrochemical instrument with a range of detectable concentrations (calculated for organic carbon) of 10 µg/l to 1 g/l.

A.M. Tsukerman spoke about the 15th Mendeleyev Society Conference on General and Applied Chemistry, which took place in Minsk in May.

Academy of Natural Sciences Studies Nuclear Destruction of Chemical Weapons

947M0068A Moscow NEZAVISIMAYA GAZETA in Russian 29 Mar 94 p 6

[Article by Nikolay Filonov]

[Text] The agreement between the USSR and the USA on the destruction and non-production of chemical weapons and on aid measures of the multi-faceted convention on the outlawing of chemical weapons were signed on 1 June 1990. The convention on chemical weapons was worked out in 1993 and goes into effect two years after ratification. One of the reasons for the delay in ratification concerns the uncertainty in the actual destruction of chemical weapon reserves (KhO) within the specified timeframe and in the agreed upon quantities. It is especially noteworthy that the urgent need to take immediate action is also dictated by the fact that significant quantities of toxic agents (OV) and weapons armed with them have now been in storage for over 20 years while the garenteed safe storage period is 10-15 years.

At the present time we can name four methods for destroying OV, each of which has been perfected to some degree: chemical, thermal burning, plasma-chemical, and nuclear.

Development of nuclear-blasting technology (YaVT) for destroying toxic materials was conducted since the end of the 1980's at the All-Union Scientific Research Institute of Experimental Physics (VNIIEF) (Aramas-16, Federal Nuclear Center RF) in initiative order as one of the options for utilizing the energy of peaceful nuclear explosions. In 1991 the work was supported by the Commission on Military-Industrial Problems by the government, and part of the work on perfecting individual elements was carried out within the framework of the agreement with Administration of Chemical Troops, MO [Ministry of Defense], in cooperation with other organizations (GosNIIOKht, VNIIPIPT, and others).

In essence, nuclear blasting consists of utilizing the energy of a nuclear explosion, concentrated in a space adjacent to the charge for tthermo-mechanical destruction and thermochemical decompostion of the materials. These materials could be not only chemical weapons, but also various devices, industrial wastes, etc. The pressure in the shock wave during a nuclear explosion is 5E12 Pa and higher in heat output, exceeding the specific energy for decomposing rocks (4.2-8.4 kJ per gram), the destroyed materials evaporate, decompose and are subsequently blended with the mass of molten rock surrounding the hollow formed by the explosion. After cooling, the melt of silicate rocks and harmful substances are transformed into a highly inert glassy state.

The accumulated experience on the organization and conduct of underground nuclear explosions garantees radiational safety when using nuclear blasting. This is achieved by the corresponding wording in the conduct of the operations, fullfilling of definate requirements under engineering-geological conditions of the place for conducting the operations, building of a gallery, a blocked complex, as well as the use of special nuclear devices having a low threshold of activity during explosion of radionucleides.

As a result of conducting experimental operations under polygon conditions (the MO polygon "Shikhany") using real toxic agents (sarin, mustard), it was demonstrated that under the conditions of a nuclear explosion, the decomposition of highly toxic substances exceeds ten million fold. Toxicological studied indicated that the decomposition products of these toxic agents may be compared to substances having 5th-6th class toxicity, i.e. these products are practically non-toxic and may be considered harmless.

The bulk of accumulated chemical weapons in Russia is estimated to be about 400,000 tons gross weight, including 40,000 tons of actual toxic agents. According to the accumlated data on the destruction of the entire volume chemical weapons, Russia will be required to carry out technological explosions having a combined power of about 4 Mt (for example, 40 explosions of 100 Mt each), while the cost of these operations may be set at 400-800 million dollars (as compared with a cost of 10-20 million dollars for nuclear blasting in a single gallery with a 10 Mt blast). This sum is significant, being 50-10 times less than the estimated cost of chemical weapon destruction by thermal burning. The duration of the process of destroying chemical weapons may be estimated at 4-8 years at 0.5-1 Mt per year using technological explosions. Chemical weapons are proposed to be destroyed in galleries at great depths, about 600 meters, at special polygons made for this purpose and having the appropriate geological structure of the earth's crust.

Concerning the need to transport (which of course cannot be refferred to the advantages of the method) the weapons to the place of their destruction, the VNIIEF examined worked out this problem. The project envisions using the many years of experience in the use of nuclear weapons to develope special modules to pack and ship containers designed for safe preservation of toxic agents during shipping and handling operations. The use of nuclear blasting to destroy chemical agents together with its other advantages (low cost, realistically short time periods for carrying out the operations, and others) have significant advantages over all other previously noted methods in still another aspect. In this case there is no need to conduct dangerous operations on disarming the weapons, decontamination and subsequent use of containers, devices, etc. in which the toxic agents were stored and must be absolutely destroyed in accordance with the requirement on column IV, Part 5 of the Agreement dated 1 June 1990.

Concrete realization of the project to destroy chemical weapons by nuclear blasting is encumbered in many ways: starting with the moratorium on underground nuclear explosions, and the negative outlook of a significant part of society to nuclear technology in general. Taking into account the ecology and low cost of the proposed method, as well as the volume of completed developmental work, it would appear to be advantageous and necessary to conduct one technical test as a demonstration. In view of the fact that the problem itself carries a global character, representatives from both nuclear and non-nuclear should be invited to prepare and participate in the experiment, thereby providing international ecological and technical

control. In regard to the positive results of the proposed demonstration, scientists of the Russian Nuclear Center have no doubts.

On 8 February 1994 this problem was discussed widely at a scientific-technical seminar on the subject: "Nuclear-Explosive Method for Destroying Chemical Weapons and Highly Active Wastes from Nuclear Energy". The seminar was conducted by the Division of Ecology of the Geopolitics and Safety Section of the Academy of Natural Sciences. An adopted resolution noted the advantages of alloting the necessary funds to develope research on founding and developing nuclear-explosive technology to bury highly active radioactive wastes and to destroy chemical weapons as being the most promising from both the ecological and economic points of view.

According to official data, American reserves of chemical weapons when recomputed to toxic agents comprise about 32,000 tons. In the USA during the 1980's a program was undertaken to destroy chemcical agents based mainly on the principle of burning the toxic agents in specially equiped furnaces. The technological process provides for delivery of the weapons and containers holding the agents to enterprises for destruction, disarming by separation into streams, destruction of the materials in each stream according to its own technology. Also stipulated is the collection of off gases and repeated burning of any toxic substances found in them, cooling and purification of any gaseous products, ash, traces of toxic substances, oxides of nitrogen and carbon, and burial of solid wastes in hermetically sealed tombs. Furthermore, there is no 100 percent guarantee of destruction of toxic wastes, and therefore the USA Department of Health established limiting allowable concentrations of toxic agents in populated areas and in the gaseous emissions of enterprises engaged in the destruction toxic agents. The problem of evaluating the degree of danger to people, animals, and plants of long term action of toxic agents at concentrations exceeding the limited norms and their mixtures with fuel gases remains unresolved.

In an exchange of opinions with American specialists of nuclear laboratories in 1992, it was established that they formulated principles similar to ours for the destruction of chemical weapons based on underground nuclear explosions and conducted a predetermined amount of research. However, due to circumstances (resulting from powerful lobbying), preference was given to the method of thermal burning. Thus, ten years later, in the USA a single experimental unit operates in Toole (state of Utah) and an enterprise on Johston atoll, which never did reach designed capacity. Construction is expected to be completed in 1993-94 of an additional seven enterprises which will provide destruction of toxic agents for 6-8 years. Information also exits that this technology may be provided to Russia (at a price, of course), if the USA Congress confirms such a decision (unconditionally confirms—author's note).

On the basis of the above, it is not difficult to arrive at the conclusion that the technology for destroying chemical agents by nuclear blasting proposed by Russian scientists, especially under the conditions of economic crisis, leaves no alternative today.

Microfiltration Membranes with Surface Charges

947M0073A Minsk VESTSI AKADEMII NAVUK BELARUSI: SERRYA KHIMICHNUK NAVUK in Russian No 4, Oct-Dec 93 (manuscript received 10 Nov 92) pp 70-73

[Article by V. I. Grachek, L. P. Chekhovich, and V. A. Artamonov, Physical Organic Chemistry Institute, Minsk; UDC678.675(088.8)

[Abstract] The solution to many practical problems such as fine purification of medicinals, and blood and serum plasma, depend to a large extent on the size of the charge and the electrokinetic potential of the membrane surface. There are two known methods for increasing the charge on membrane surfaces: introduction of modifiers during the membrane forming stage, and treating the pre-formed membrane with modifiers. The present work is concerned with the latter method. Polycaproamide microfiltration membranes of 0.2 microns pore size were treated with various modifiers and the electrokinetic (zeta) potential of the surface determined along with the cationic adsorption capacity of the membrane. Modification of the pre-formed membranes makes it possible to obtain positive surface charged microfiltration membrane filters having an enhanced capability of capturing particles having an opposite charge with no change in sign of the zeta potential within the pH range of 3.7-10.5. The modified membranes were also found to retain their structure. Figure 1; references 8: 1 Russian, 7 Western.

ANALYSIS,TREATMENT,MINING

Boronizing Laser Treatment of Titanium Alloys

947D0022A Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 1, Jan 94 pp 14-15

[Article by V.S. Postnikov and M.N. Tagirov, Perm State Technical University; UDC 621.9.048:621.785.53: 669.295.5]

[Abstract] In an effort to increase the low wear resistance of titanium and its alloys so as to make them suitable for friction pairs, surface hardening of the WTi3-1 Ti + 3% W alloy by boronizing laser treatment was tried in an experiment with a pulsed "Kvant-15" laser. The treatment was followed by structural examination under an MIM-8 optical microscope and phase analysis in a DRON-2.0 x-ray diffractometer with a CoK_{α}- radiation source and monochromator. Microhardness was measured with a PMT-3 tester. The surface layer was found to contain the α-Ti phase, the rutile TiO_2 phase, titanium borides TiB, Ti_3B_4, Ti_2B_5, and boron carbide B_4C. Its structure was found to consist of an about 270 μm thick dendritic flash zone with a microhardness of 950-1000 N and a wide bright heat-affected zone underneath characterized by a microhardness monotonically decreasing down to the 320 N pretreatment level at 500-600 μm depth below the surface. A drawback of boronizing laser treatment is its embrittling effect on the surface layer. In an effort to minimize the tendency to cracking, formation of a composite B_4C and chromium lubricant coating by similar laser treatment was tried in another experiment. Three composites were considered: 1) 25% Cr + 75 % B_4C, 2) 50% Cr + 50% B_4C, 3) 75% Cr + 25% B_4C. The first one was found to most effectively increase both ductility and wear resistance, thus also to appreciably decrease the friction coefficient, especially upon addition of CaF_2. Figures 2; tables 1.

COMPOSITE MATERIALS

Argon-Arc Welding-On Titanium Dowels to Inserts for Aircraft Structures Made of Composite Materials

947D0035A Kiev AVTOMATICHESKAYA SVARKA in Russian No 1, Jan 94 (manuscript received 5 Dec 93) pp 36-38

[Article by N.M. Tarasov, doctor of technical sciences, and V.G. Datchenko, engineer, Kharkov Institute of Aviation; UDC 621.734'293: 669.295-233.16:629.73]

[Abstract] In aircraft structures which include components made of composite materials the latter are joined to metal (titanium) parts with the help of metal (titanium) dowels. The dowels are welded on to the metal parts for insertion into the composite material so as to enhance the strength and the reliability of the joints. In an investigative study of this technology and specifically of the automatic argon-arc weld-on process, dowels made of titanium alloys WTi6, WTi16, and OTi4 were welded on to blank parts made of OTi4-1, OTi4, and WTi6 titanium alloys. Such welding-on of titanium dowels is attended by shifting of the arc column and random displacements of the active spots. The unique feature of such metal inserts for use in aircraft construction is their intricate surface profile, featuring a large number (up to several thousand) closely spaced small (3-5 mm long and 1.0-3.0 mm in diameter) dowels. In the experiment such inserts were joined to parts made of ELUR-P-0.08 composite on a carbon ribbon base. The weld-on process was tracked with an SKS-1M high-speed camera. This facilitated monitoring not only the stability of the electromagnetic setting mechanism but also the synchronization of the setting process with the arcing process. The main criterion for selection of the weld-on process parameters was found to be the fillet, its size and shape at the dowel weld-on site determining how reliable the dowel embedment in the composite material will be. Since spatial instability of the arc column and the active spots inhibits formation of desired fillets, special means of stabilizing them are required. In the experiment this was accomplished by means of an external longitudinal magnetic field forming an array of welding pools on the surface of the blank insert: spherical pools coaxial with the to be welded-on dowels and thus ensuring formation of desired fillets. Subsequent weld-on was found to be done most effectively in the "stiff" mode, with the shortest possible arc duration and the maximum possible arc current. Bilateral symmetric doweling of the inserts was found to minimize their later deformation, especially when the dowels have been optimally spaced and welded-on in the most efficient sequence. In order to still prevent appreciable later deformation of large and not very rigid titanium inserts, it is recommended that the dowel weld-on operation be followed by a heat treatment: isothermal vacuum annealing. An automatic argon-arc welding machine with numeric program control has been developed and built for this special application. It is designed to weld-on dowels 1-3 mm in diameter at assigned locations precisely within 0.01 mm: 10,000 of them in one operation at a rate of 900 per hour. The arc duration can be regulated over the 0.01-1.0 s time range and the arc current can be regulated over the 40-200 A range, with an argon consumption of 0.6-1.0 l/min. The machine weighs 1400 kg. Figures 3; references 5.

Method of Reducing Level of Thermally Stressed State of Gas Turbine Engine Blades by Selecting Optimum Thickness Distribution of Ceramic Heat Shield Coating

947D0029A Kiev PROBLEMY PROCHNOSTI in Russian No 1, 1994 (manuscript received 18 Jun 92) pp 62-67

[Article by G. N. Tretyachenko, Yu. A. Gribkov, B. S. Karpinos and V. V. Samuleyev, Kiev, Institute for Problems of Strength, Ukrainian Academy of Sciences, Kiev Air Force Institute; UDC 539.43]

[Abstract] The authors develop a method of optimizing the thermally stressed state of turbine blades by varying the thickness distribution of ceramic heat shield coatings. The numerical method of elementary heat balance was used to solve the problem of heat conduction. It is shown that the error of temperature determination is not more than 3.5 percent. The proposed optimization procedure can be used

to design gas turbine engine blades with minimum level of temperature nonuniformity, and to reduce thermal stresses in transient modes of power plant operation. Figures 7, formulas 3, references 10.

Certifying Modern Ceramics for Mechanical Properties

947D0029B Kiev PROBLEMY PROCHNOSTI in Russian No 1, 1994 (manuscript received 4 Nov 91) pp 68-75

[Article by G. A. Gogotsi and V. P. Zavada, Kiev, Institute for Strength Problems, Ukrainian Academy of Sciences; UDC 620.174:666.3/7]

[Abstract] For the last ten years, based on accumulated experience in studying the mechanical behavior of ceramics, graphite, composite materials, refractories and glass, the authors have been attempting to develop a structured certification (pretesting) system aimed primarily at ceramics intended for engine construction and in other high-temperature applications. The described testing methods and equipment used in implementing the system have been tried on the most diverse materials of poor deformability. Materials covered include not only polycrystal and single-crystal ceramics, but also domestic and foreign composites and refractories. Experience has been accumulated that can be used in setting up a Ukrainian system of ceramics certification analogous to those used in other European nations. Figures 4, tables 3, references 29.

Superplastic Ceramic: Possibilities for Application in Modeling Pressworking Manufacturing Processes

947D0031A Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 4, 1994 pp 13-18

[Article by Ye. M. Chumachenko, candidate of technical sciences, and O. M. Smirnov, doctor of technical sciences (A. N. Yershov and N. N. Pozhidayev assisted in preparing the manuscript); UDC 621.77.01:666.3.001]

[abstract] The authors explain the principles underlying superplasticity of certain ceramics, and give specific equations that describe their physical and rheological properties, and their behavior in terms of stress, deformation, strain rate, temperature and so on, as applied to an isotropic, irreversibly deformable medium with properties determined by the strain rate tensor at a given instant. An algorithm is given for solving these equations. A comparison of results of calculations by the proposed algorithm with experimental data shows close agreement. As an example of application of the results, the authors consider stamping of a disk blade from a previously prepared blank, demonstrating the effectiveness of using mathematical modeling methods with the SPLEN-S (KERAMI) software package for configuring dies and predicting properties of the finished part that are significantly dependent on final density distribution. Figures 3, formulas 15, references 19.

Monitoring Strength of Ceramics by Acoustic Emission

947D0034A Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 94 (manuscript received 4 Nov 91) pp 83-88

[Article by S.T. Nakolskiy and T.S. Stepanyants, State Technical University, St.Petersburg; UDC 621.179.16: 620.178.3]

[Abstract] Structural examinations of ceramic products by the two methods of acoustic emission and electron microscopy have revealed that their catastrophic fracture under load follows a nucleation of stable not propagating microcracks within microscopic regions under most unfavorable combination of stresses and a subsequently rising concentration of these microcracks, which then merge into larger ones while also pulling in new ones till a significant defect is formed. On the basis of this evidence is being considered using the acoustic emission method for monitoring the strength of ceramic products under loads of either short or long duration. In order to be able to accurately and reliably predict the magnitude of the breaking load and thus the ultimate strength of the object, its necessary to correlate both duration and amplitude of acoustic emission pulses with the load parameters as well as the pulse count rate with the defect growth rate. Tests have already been performed on a wide range of ceramics, from ultrafine-grained KO optical ones, piezoceramics, ferrite ceramics, alumina, electrical-grade porcelain, to coarse-grained concrete, with varying degrees of porosity each. Typically, hemispherical specimens were tested in compression and in flexure (three-point scheme) under acoustic loading pulses, emission signals being recorded during loading and after unloading. An evaluation of the results indicates that it is feasible to inspect ceramic products nondestructively by the acoustic emission method, when the specific technique and the signal parameters appropriately match the given kind of material. The results also reveal that holding the product under no load after such an inspection not only will restore, but also may increase its strength. Figures 2; tables 1; references 15.

Physical and Mechanical Properties of Al_2O_3 + ZrO_2:Y_2O_3 Composite Produced by Directional Crystallization from Melt

947D0024A Moscow OGNEUPORY in Russian No 12, 1993 pp 5-7

[Article by V.N. Savushkin, M.D. Lyubalin, and V.A. Pismennyy, Scientific Research Institute of Refractory Materials Technology; UDC 666.762.11.017]

[Abstract] A composite ceramic material on the basis of partly stabilized zirconia and featuring a high flexural strength along with a high stress intensity index was produced experimentally by the Bridgman method of vertical crystallization from melts under a vacuum of about 1.3 Pa: a eutectic Al_2O_3 + ZrO_2 mix with ZrO_2 stabilized by about 4% Y_2O_3. Six composites had been synthesized with the alumina content varied from 50.0% to 70.0%, the 54.0% Al_2O_3 + 44.16% ZrO_2 + 1.84% Y_2O_3 ceramic (density 4.70 g/cm^3) having the highest flexural strength of 420 N/mm^2 at 20°C temperature (249 N/mm^2

at 1000°C, 314 N/mm^2 at 1300°C) and the largest stress intensity index K_{Ic}= $PY_{min}/WH^{1/2}$ = 10.7 N/mm$^{3/2}$ (P- breaking force, W- width of specimen, H- height of specimen, Y- design factor). This method of producing such ceramics is evidently preferable to the "powder" method, inasmuch as it does not require preparing ultrafine-disperse ingredients and maintaining a high pressure at a high temperature. Tables 1; references 8.

METALS

Metallurgical Quality of Pipeline Steels and Problem of Their Stress- Corrosion Cracking

947D0028A Moscow GAZOVAYA PROMYSHLENNOST in Russian No 11, 1993 pp 27-28

[Article by V.D. Tarlinskiy and A.S. Bolotov, All-Russian Scientific Research Institute of Pipeline Construction; UDC 621.643.23]

[Abstract] Inasmuch as the metallurgical quality of high-alloy pipe steels is determined principally by their resistance to stress-corrosion cracking caused by aggressive pipeline media, this process is examined by considering the (E+G+S)/(external influencing factors) → Me/(effect on internal system) interaction scheme (E- action of external electric or electromagnetic fields and of cathodic protective on; G- action of electrolyte in the ground; S- action of operating and residual stresses; Me- metallurgical quality of steel). Into account is taken dependence of the cracking rate on the structural characteristics of the soil, its granularity and degree of homogeneity, as well as composition and pH of the electrolyte. Most detrimental are weak acids (pH 7.5) containing 15 mmol./l Ca++ + Mg++ and 1 mmol./l Cl- ions, the ground "atmosphere" then usually consisting of nitrogen with at least 5% CO + CO_2 and not more than 10% oxygen. The cracking rate increases when the hydrogen overvoltage is lowered by external conditions such as a temperature rise, an increase of the electric current density, or roughness of the interaction surface. Possible cracking mechanisms include, besides anodic dissolution, are hydrogen blistering and "wedging" by surface active agents. Which of these mechanisms will be the dominant one is determined by the ratio of corrosion rate to actual hydrogen diffusion rate, the former depending among others on the effectiveness of cathodic protection under otherwise equal conditions and the latter depending primarily on the macrostructure of the metal. When anodic dissolution is suppressed and hydrogen blistering thus becomes the dominant mechanism, crack growth will proceed already before the critical hydrogen content is reached. The more the electrochemical activity of the host metal differs from that of the carbide phase or of the nonmetallic inclusions at the grain boundaries, the more intense will be the stress- corrosion cracking process. On the one hand chemical and structural nonhomogeneity gives rise to formation of microgalvanic pairs causing anodic dissolution. On the other hand large chemical and structural gradients intensify the hydrogen redistribution process in the stress field. A higher probability of critically nonhomogeneous metal surface segments interacting with the electrolyte in the soil thus corresponds to a higher probability of crack initiation and evolution by any mechanism. Stress-corrosion cracking, which can be either intercrystalline or transcrystalline, is influenced by the nature of grain boundaries largely dependent on the steel processing and pipe manufacturing technology. It is also influenced by the interaction of diffusing hydrogen with other inclusions, more detrimental being its interaction with films enveloping grain boundaries than with globular and polyhedral inclusions. Most undesirable are sulfides and phosphides, not so much nitrides and carbonitrides. Heat treatment and mechanical forming should be designed to ensure that neither ferrite boundary layers nor acicular structures will develop in the process. Also the allowable content of the austenitic martensitic microphase should be low. While addition of Al and Zr microquantities to the solid solution may be beneficial, addition of molybdenum may be problematic. Attention should be paid to Cr, Ni, and Cu impurities. Tables 2.

Influence That Microalloying With Rare Earth Elements Has on Resistance of Steels to Deformation and Fracture Under Alternating Elastic-Plastic Loading

947D0029A Kiev PROBLEMY PROCHNOSTI in Russian No 1, 1994 (manuscript received 6 Oct 92) pp 12-17

[Article by V. N. Kiselevskiy, V. V. Kovalev, D. F. Kharitonov, I. M. Neklyudov and L. S. Ozhigov, Institute for Problems of Strength, Ukrainian Academy of Sciences, Kiev, Kharkov; UDC 539.4]

[Abstract] A comparative study is done on the mechanical properties of type KhNS-4 steel, in particular the resistance to brief elastic-plastic cyclic loading at 923 K under ordinary and radiation conditions. The steel base is 0Kh16N15M3B austenitic stainless steel after vacuum remelting and microalloying with Sc. In addition, analogous results are given for type KhNS-5 steel, the prototype being grade Kh13N13T3 steel after microalloying with Sc. It was found that remelting and microalloying with rare earth elements increases cyclic durability. Irradiation (φ = 4.5 x 10^{17} N/m^2 x s, $E \geq 0.1$ MeV) increased the resistance of KhNS-4 steel to cyclic fracture as contrasted with 0Kh16N15M3B steel, for which the reverse pattern was observed. A correlation is observed between the level of the strain hardening factor and the number of cycles to fracture for a fixed amplitude of cyclic deformation. This factor is greatest for 0Kh16N15M3B steel and least for KhNS-5, and cyclic durability increases in conformance with this order. This conclusion is confirmed by studies of KhNS-4 steel: radiation damage increased the strain hardening factor with a corresponding increase in cyclic durability in contrast to 0Kh16N15M3B, in which irradiation reduced both these quantities. Figures 3, table 1, references 4.

Grade 14MnNi2MoVN$_2$ Structural Steel for Heat Exchanger Parts

947D0023A Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 1, Jan 94 pp 16-20

[Article by M.M. Sandomirskiy, N.A. Shulgan, A.A. Astafyev, V.A. Yukhanov, and S.V. Demyantsevich, Izhorskiye Zavody [Izhorsk Works] Joint Stock Co and Scientific-Industrial Association "Central Scientific Research Institute of Machine Manufacturing Technology"; UDC 669.14.018.298:620.1.193]

[Abstract] An experimental study of nitrided grade 14MnNi2MoV structural steel (0.14-0.18% C, 0.5-0.9% Mn, 1.8-2.2%Ni, 0.25-0.35% Mo, 0.03-0.07% V, 0.005-0.015% Ti, Mo/C= 0.08-0.31, $\leq$ 0.020% S, $\leq$ 0.020% P)) was made concerning its suitability for heat exchanger parts. Industrial steel from an electric-furnace was cast into 51.8 ton and 55.6 ton ingots for respectively forging and rolling down first to 300 mm thickness, then further into successively thinner strips and sheets. Some ingots were only turned down to 32 ton size. Some up to 185 mm thick strips were welded together in an automatic machine with 10MnNi1MoA$_2$ rod under FTs-16 flux. Steel made in the laboratory furnace was cast into 50 kg ingots. Mechanical tests were performed after preliminary heat treatment (water quenching from 900-920°C + tempering at 640-660°C for 10 h) and after supplementary heat treatment (tempering at 610-630°C for 15 h + tempering at 640-660°C for 30 h) meant to simulate the industrial process. The test data include: change of 0.2 % yield strength, ultimate strength, and 50% embrittlement temperature as a result of heat treatments; temperature dependence of strength (0.2% yield, ultimate) and plasticity (percentage elongation, percentage area reduction) over the 0-350°C range; dependence of all four mechanical properties at 20°C on the length of aging time at 350° up to 10,000 h; temperature dependence of cracking resistance index K_c (N/mm$^{3/2}$) over the 0-(200)°C range and of impact strength over the 20-(-200)° range. The results indicate that the dependence of the strength indicators on tempering temperature and time does not coincide with its dependence on the Hollomon-Jaffe variable P= T(20 + log τ) [J.A. Hollomon, L.D. Jaffe; TRANSACTIONS, AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERING: IRON AND STEEL DIVISION, Vol 162, 1945], unless no noticeable structural transformation have taken place during the tempering process. They also indicate an improvement over the 10MoNi2MoVN$_2$ (Mo/C= 0.42-1.10, no Ti) grade in terms of stability and mechanical properties, evidently owing to homogeneity of the carbide phases and absence of carbide transformations. Figures 6; tables 2; references 8.

Hypercube Microprocessor System Architecture With the Processor Elements Located Along the Cube's Edges

947G0028G Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian No 2, Mar-Apr 94 (manuscript received 8 Nov 93) pp 170-182

[Article by P.P. Parkhomenko, Moscow; UDC 519.7]

[Abstract] In the overwhelming majority of publications dealing with hypercube microprocessor system architectures, the processor elements are located at the hypercube's vertices. A microprocessor system architecture in which the processor elements are located along the hypercube's edges was proposed and examined. The examination focused on a 4-dimensional hypercube architecture permitting economical and simple organization to system doubling and tripling. Configuring the system's processor elements along the hypercube's edges rather than vertices was shown to simplify the hardware required for the channel elements of links between the processor elements. The binary hypercube examined was represented in terms of a table that was analogous to a Carnot matrix but that differed from a Carnot matrix by virtue of the fact that the elements of its cells are the names of the hypercube's vertices. The analysis began with an examination of several possible ring structures based on a hypercube microprocessor system architecture. An estimate of the cardinality of the set of Hamiltonian cycles with a length of 2^2 in an n-dimensional hypercube placed the upper estimate of possible Hamiltonian cycles for a four-dimensional hypercube at 360 versions of 16-processor ring structures of interprocessor links. Next, the possibilities of organizing ring structures in the event of microprocessor system component failures was assessed. The procedures involved in finding operable ring structures after the failure of working processor elements or channel elements were examined along with ways of making the ring structures of microprocessor systems redundant. The technique of organizing Euler cycles in a four-dimensional hypercube by "joining" pairs of Hamiltonian cycles with nonintersecting sets of hypercube vertices included in the latter was discussed along with the possibility of software implementation of Euler cycles by controlling channel elements in a time share mode. The possibility of tripling ring structures in a microprocessor system was examined. Dichotomous and trichotomous tree structures of microprocessor links that may be organized in an n-dimensional hypercube were considered, and a heuristic algorithm for constructing such trees was described. The analysis concluded with an examination of interprocessor information exchange in a hypercube microprocessor system structure. Figures 2, tables 8; references 3 (Western).

Multiprocessor Systems With Intelligent Control

947G0028J Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian No 2, Mar-Apr 94 (manuscript received 8 Nov 93) pp 198-203

[Article by A.G. Shigin, Moscow; UDC 658.012.011.56]

[Abstract] A multiprocessor system that is intended for wide-scale use and that includes means of intelligent control has been described. The system features a dynamic planning system that enables it to be adjusted for the class of tasks being performed. The programs for completing tasks are represented in terms of large blocks that contain all of the input data that has been obtained as a result of execution of the program's preceding blocks and that is necessary to perform further calculations. Program blocks are formulated in a program-controlled processor while the program is being processed at the block level according to the dataflow control diagram. As soon as they are formulated, program blocks are directed to a free processor. Because the controllers of adjustable multiprocessor systems such as the one described must execute extremely complex and diverse control processes that change dynamically depending on the features of the tasks assigned to the multiprocessor system, the specified quality indicator, and the status of the system's hardware, the proposed multiprocessor system was designed to include an intelligent controller based on an expert system that would enable the controller to automatically make task blocks parallel and synchronize them and automatically set up tasks. The Computers and Computer Systems and Networks Department of the Moscow Power Engineering Institute conducted a model experiment to evaluate the proposed multiprocessor system with an expert system-based intelligent controller. The expert system was created by using the shell GURU. The experiment confirmed the possibility of developing an adjustable multiprocessor system that could assign tasks to free processors. Use of a controller directed by the expert system made it possible to increase the load of individual processors by 20 to 35 percent when compared with that in a multiprocessor system in which no expert system was used. The following were among the recommendations regarding multiprocessor systems that were formulated as a result of the experiment: the expert system must include a multistep decision-making model to permit the selection of available processors, decision-making arguments must be structured so as to make it possible to give priority to tasks designated as having priority, and the expert system's knowledge base should be designed in the form of a semantic net so as to be able to represent the deep structure of knowledge regarding the task stream and the multiprocessor system's structures. Figures 2; references 5 (Russian).

Conceptions of Constructing Information Management Networks for Distributed Objects

947G0028E Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian No 2, Mar-Apr 94 (manuscript received 8 Nov 93) pp 137-146

[Article by V.A. Zhozhikashvili and V.N. Silayev, Moscow; UDC 681.142.2]

[Abstract] During the 20 years of the Sirena aircraft seat reservation and ticket sale system's operation, its high efficiency and the possibility of staged modernization and expansion of its volume and functional characteristics have been confirmed. In the Sirena-1 system, user requests were teleprocessed in a centralized network with a single

host computer. The current Sirena-2 system, on the other hand, features network processing in a decentralized network of host computers linking up to 300 cities and population centers. The plan for the Sirena-3 system, which was developed in 1991, calls for an integrated network transmitting data from different civilian air traffic sources and other departments whose user terminals will be connected to the network on a commercial basis. The network will permit faster modulation in physical channels and concentration in standard voice-frequency channels of both data traffic and speech information and will use a standard protocol profile and centralized-decentralized network control. On a practical plane, the Sirena-3 system will solve the problem of making the transition from a narrow-function to a multifunctional integrated automated management system with integration of data traffic and analog speech information. The distinctive features of the Sirena-3 system as a representative automated queuing system were considered. Specifically, it was described in terms of a transition from an automated to an automatic system in which clients obtain all the documents they need to use the system's resources in a self-service mode and in which interaction between the human components of the automated queuing occurs during a process of direct audio visual contact. The economic factors affecting automated queuing systems' feasibility were considered along with their user service methods. An approach based on pipelining with self-service was considered promising because its efficiency in the preliminary stages does not depend on the presence or absence of an external queue and because users could interact with the host computer until a positive response is received. The question of interaction protocols and interfaces in automated queuing systems was considered, and standard protocols and interfaces were favored. Plans to increase the speed with which information reaches users in a logical channel based on the combined use of external and internal priorities were presented along with a three-step plan for conversion of a special-purpose network based on standard voice-frequency channels of analog communication systems to an integrated network of data and analog (i.e. speech) information transmission. Finally, the eventual integration of various data traffic in accordance with the concept of a global system of organizing air traffic was discussed. References 13: 9 Russian, 4 Western.

Synthesizing Automatic Control Systems With a Trainable Fuzzy Controller Based on a Neural Network

947G0028I Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian No 2, Mar-Apr 94 (manuscript received 8 Jul 93) pp 192-197

[Article by R.G. Abiyev, R.A. Aliyev, and R.R. Aliyev, AzIU (expansion not given), Baku; UDC 007.57]

[Abstract] An attempt was made to use a neural network-based fuzzy knowledge base to improve the operating quality of a real control object at an oil refinery. First, a neural network architecture was developed that consisted of a three-layer "feedforward" structure whose layers contained input, buried, and output neurons (nodes). The control object was described in the form of production rules, and the problem of synthesizing a model of an intelligent automatic control system with a fuzzy controller in its structure was considered. A "backpropagation" algorithm was used to train the neural network. Software written in Turbo-Pascal was developed for computer modeling of the automatic control system with a neural expert system. The resultant neural network-based automatic control system was used to control the temperature of overflow into the stripper of the atmospheric unit of a primary oil refining unit. The system proved superior to a conventional self-actuated [PD] controller. Next, a neural network-based automatic control system with a fuzzy controller was created. It too was based on a three-layer "feedforward" structure. The automatic control system was given the desired fuzziness by feeding all input terms-sets of linguistic variables through a fuzzificater after they had been scaled, and the neural network was trained by using the proposed algorithm and fuzzy arithmetic. The entire fuzzy arithmetic was implemented for fuzzy numbers of the *LR* type. A comparative evaluation of the operation of an automatic control system with a fuzzy controller and neural network with no provisions for fuzzy process control confirmed the superiority of the automatic temperature control system developed on the basis of fuzzy neural technology. Figures 5, tables 2; references 4: 1 Russian, 3 Western.

Analysis of Speech Signals Based on an Acoustic Model

947G0028F Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian No 2, Mar-Apr 94 (manuscript received 8 Nov 93) pp 147-153

[Article by S.N. Kirillov and D.N. Stukalov, Ryazan Electronics Institute, Ryazan; UDC 534.4:621.391]

[Abstract] An acoustic model was used to analyze the variability of speech as a result of distinctions between different individuals' voices, external noise, and characteristics of the path receiving speech signals of Russian speech. The analysis established that because of the aforesaid factors, recognition of phonemes of Russian speech by conventional methods with a signal:noise ratio at the recognition device's input of [4]0 dB is fraught with significant difficulties. Identification of signals of phonemes of spoken Russian based on a Euclidean metric by using parameters of an acoustic model of a voice track was found to result in a higher recognition efficiency than is achieved when other similarity measures are used. An acoustic function was proposed that permits automatic identification of the most informative segments of signals of Russian phonemes (i.e., those segments that do not depend on the duration of phonemes' pronunciation). Procedures developed on the basis of the proposed acoustic model of a voice track and involving quasi-invariant transformations of the level, frequency, and time of phoneme signals were tested in an experimental setup that included an MD-85A microphone, amplifier with a cutoff frequency of 10 kHz, 12-bit analog-digital converter, and YeS-1841 and Iskra-1030 computers. The experiments established that use of the proposed acoustic function and algorithms improves the grouping of recognition

features and permits the recognition of 24 basic Russian phonemes with a probability of at least 0.93. An added benefit of the proposed algorithms is that they may be successfully executed in real time on microprocessors produced in Russia. Figures 2; references 9: 8 Russian, 1 Western.

Parallel Architecture for Arbitrary-Length Convolution Processor Using Numerical Ryder Transforms

947G0028H Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian No 2, Mar-Apr 94 (manuscript received 12 Jun 93) pp 183-191

[Article by O.V. Klimova, State Machine Science Scientific Research Institute, Russian Academy of Sciences, Moscow; UDC 681.323]

[Abstract] A parallel, parametrically adjustable algorithm for calculating a cyclic convolution of arbitrary length that involves the use of numerical Ryder transforms and that is oriented toward the use of parallel architectures was constructed. A theoretical-group approach was taken to the problem of decomposing a direct convolution algorithm. The decomposition method used made it possible represent the starting cyclic convolution in the form of the sum of independent cyclic convolutions of greater dimensionality. The parallel algorithm developed to calculate long convolutions by using numerical Ryder transforms may be used to formulate a class of parallel-pipeline architectures specified by a system of algorithmic and architectural parameters. The algorithm makes it possible to select that version of a specified class of architectures with the best ratio of hardware and time expenditures. The algorithm may therefore be used either to maximize the efficiency of parallel computer systems by adjusting them for the existing degree of hardware parallelism or to create parallel special-purpose processors with required hardware-time characteristics. Figures 3; references 6 (Russian).

Hypercube Microprocessor System Architecture With the Processor Elements Located Along the Cube's Edges

947G0028G Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian No 2, Mar-Apr 94 (manuscript received 8 Nov 93) pp 170-182

[Article by P.P. Parkhomenko, Moscow; UDC 519.7]

[Abstract] In the overwhelming majority of publications dealing with hypercube microprocessor system architectures, the processor elements are located at the hypercube's vertices. A microprocessor system architecture in which the processor elements are located along the hypercube's edges was proposed and examined. The examination focused on a 4-dimensional hypercube architecture permitting economical and simple organization to system doubling and tripling. Configuring the system's processor elements along the hypercube's edges rather than vertices was shown to simplify the hardware required for the channel elements of links between the processor elements. The binary hypercube examined was represented in terms of a table that was analogous to a Carnot matrix but that differed from a Carnot matrix by virtue of the fact that the elements of its cells are the names of the hypercube's vertices. The analysis began with an examination of several possible ring structures based on a hypercube microprocessor system architecture. An estimate of the cardinality of the set of Hamiltonian cycles with a length of 2^2 in an n-dimensional hypercube placed the upper estimate of possible Hamiltonian cycles for a four-dimensional hypercube at 360 versions of 16-processor ring structures of interprocessor links. Next, the possibilities of organizing ring structures in the event of microprocessor system component failures was assessed. The procedures involved in finding operable ring structures after the failure of working processor elements or channel elements were examined along with ways of making the ring structures of microprocessor systems redundant. The technique of organizing Euler cycles in a four-dimensional hypercube by "joining" pairs of Hamiltonian cycles with nonintersecting sets of hypercube vertices included in the latter was discussed along with the possibility of software implementation of Euler cycles by controlling channel elements in a time share mode. The possibility of tripling ring structures in a microprocessor system was examined. Dichotomous and trichotomous tree structures of microprocessor links that may be organized in an n-dimensional hypercube were considered, and a heuristic algorithm for constructing such trees was described. The analysis concluded with an examination of interprocessor information exchange in a hypercube microprocessor system structure. Figures 2, tables 8; references 3 (Western).

Conceptions of Constructing Information Management Networks for Distributed Objects

947G0028E Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian No 2, Mar-Apr 94 (manuscript received 8 Nov 93) pp 137-146

[Article by V.A. Zhozhikashvili and V.N. Silayev, Moscow; UDC 681.142.2]

[Abstract] During the 20 years of the Sirena aircraft seat reservation and ticket sale system's operation, its high efficiency and the possibility of staged modernization and expansion of its volume and functional characteristics have been confirmed. In the Sirena-1 system, user requests were teleprocessed in a centralized network with a single host computer. The current Sirena-2 system, on the other hand, features network processing in a decentralized network of host computers linking up to 300 cities and population centers. The plan for the Sirena-3 system, which was developed in 1991, calls for an integrated network transmitting data from different civilian air traffic sources and other departments whose user terminals will be connected to the network on a commercial basis. The network will permit faster modulation in physical channels and concentration in standard voice-frequency channels of both data traffic and speech information and will use a standard protocol profile and centralized-decentralized network control. On a practical plane, the Sirena-3 system will solve the problem of making the transition from a

narrow-function to a multifunctional integrated automated management system with integration of data traffic and analog speech information. The distinctive features of the Sirena-3 system as a representative automated queuing system were considered. Specifically, it was described in terms of a transition from an automated to an automatic system in which clients obtain all the documents they need to use the system's resources in a self-service mode and in which interaction between the human components of the automated queuing occurs during a process of direct audio visual contact. The economic factors affecting automated queuing systems' feasibility were considered along with their user service methods. An approach based on pipelining with self-service was considered promising because its efficiency in the preliminary stages does not depend on the presence or absence of an external queue and because users could interact with the host computer until a positive response is received. The question of interaction protocols and interfaces in automated queuing systems was considered, and standard protocols and interfaces were favored. Plans to increase the speed with which information reaches users in a logical channel based on the combined use of external and internal priorities were presented along with a three-step plan for conversion of a special- purpose network based on standard voice-frequency channels of analog communication systems to an integrated network of data and analog (i.e. speech) information transmission. Finally, the eventual integration of various data traffic in accordance with the concept of a global system of organizing air traffic was discussed. References 13: 9 Russian, 4 Western.

Sequential Procedure for Making Decisions About the State of a Communication Channel Based on Testing Fuzzy Hypotheses

947G0028D Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian No 2, Mar-Apr 94 (manuscript received 8 Nov 93) pp 106-113

[Article by A.N. Gavrilov, L.A. Puzikova, and A.N. Pylkin, Ryazan Electronics Institute, Ryazan; UDC 658.012.011.56]

[Abstract] A sequential procedure for making decisions regarding the state of a communication channel in distributed control and computer networks that is based on the combined use of probability theory, Boolean algebra, and fuzzy set theory has been proposed. A linguistic model was proposed along with a method classic (Wald) and modified procedures for identifying the state of a discrete channel were simulated, and the results obtained by using each type of procedure were compared. The new procedure based on testing fuzzy hypotheses was found to reduce the average time required to make a decision regarding a discrete channel's serviceability. Figures 3, table 1; references 5 (Russian).

Analysis of Speech Signals Based on an Acoustic Model

947G0028F Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian No 2, Mar-Apr 94 (manuscript received 8 Nov 93) pp 147-153

[Article by S.N. Kirillov and D.N. Stukalov, Ryazan Electronics Institute, Ryazan; UDC 534.4:621.391]

[Abstract] An acoustic model was used to analyze the variability of speech as a result of distinctions between different individuals' voices, external noise, and characteristics of the path receiving speech signals of Russian speech. The analysis established that because of the aforesaid factors, recognition of phonemes of Russian speech by conventional methods with a signal:noise ratio at the recognition device's input of [4]0 dB is fraught with significant difficulties. Identification of signals of phonemes of spoken Russian based on a Euclidean metric by using parameters of an acoustic model of a voice track was found to result in a higher recognition efficiency than is achieved when other similarity measures are used. An acoustic function was proposed that permits automatic identification of the most informative segments of signals of Russian phonemes (i.e., those segments that do not depend on the duration of phonemes' pronunciation). Procedures developed on the basis of the proposed acoustic model of a voice track and involving quasi-invariant transformations of the level, frequency, and time of phoneme signals were tested in an experimental setup that included an MD-85A microphone, amplifier with a cutoff frequency of 10 kHz, 12-bit analog-digital converter, and YeS-1841 and Iskra-1030 computers. The experiments established that use of the proposed acoustic function and algorithms improves the grouping of recognition features and permits the recognition of 24 basic Russian phonemes with a probability of at least 0.93. An added benefit of the proposed algorithms is that they may be successfully executed in real time on microprocessors produced in Russia. Figures 2; references 9: 8 Russian, 1 Western.

Parallel Architecture for Arbitrary-Length Convolution Processor Using Numerical Ryder Transforms

947G0028H Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian No 2, Mar-Apr 94 (manuscript received 12 Jun 93) pp 183-191

[Article by O.V. Klimova, State Machine Science Scientific Research Institute, Russian Academy of Sciences, Moscow; UDC 681.323]

[Abstract] A parallel, parametrically adjustable algorithm for calculating a cyclic convolution of arbitrary length that involves the use of numerical Ryder transforms and that is oriented toward the use of parallel architectures was constructed. A theoretical-group approach was taken to the problem of decomposing a direct convolution algorithm. The decomposition method used made it possible represent the starting cyclic convolution in the form of the sum of independent cyclic convolutions of greater dimensionality. The parallel algorithm developed to calculate long convolutions by using numerical Ryder transforms may be used to formulate a class of parallel-pipeline architectures specified by a system of algorithmic and architectural parameters. The algorithm makes it possible to select that version of a specified class of architectures with the best ratio of hardware and time expenditures. The algorithm may therefore be used either to maximize the efficiency of parallel computer systems by adjusting them for the

existing degree of hardware parallelism or to create parallel special-purpose processors with required hardware-time characteristics. Figures 3; references 6 (Russian).

Object-Oriented Approach to Modeling a Subject Area

947G0028B Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian No 2, Mar-Apr 94 (manuscript received 6 Oct 93) pp 43-47

[Article by Ye.Yu. Golovina, Moscow; UDC 519.68: 681.51]

[Abstract] The problem of adequate structural description of a complex subject area is one of the main problems that must be addressed in efforts to create expert systems. At the present time, construction of a conceptual model and its subsequent formalization has begun with the identification of classes of objects, their attributes, and the relations between classes of objects. A new object-oriented approach to modeling a subject area has been proposed that permits a more adequate description of subject areas by identifying numerous classes of objects, attributes, and relations based on information presented in functional, process, and structural submodels. The proposed three-level model is examined by way of the example of modeling an energy complex, which has been selected as a representative complex control object. Construction of the first level of the conceptual model begins with the identification of the control object's main function and the subfunctions required to achieve the main function. The process model that constitutes the conceptual model's second level describes those processes occurring in the subject area's objects (facilities) and is represented in the form of a data-flow diagram. Construction of the structural model constituting the conceptual model's third level entails describing the control object's hierarchy of succession and subordination and identifying the operations, attributes, and relations of classes of objects and specifying a representative of each class. The entity-relationship diagram is one form in which the structural submodel may be represented. The object-oriented approach to modeling a subject area involves the use of a hybrid model that combines program engineering and knowledge engineering. Multi-Layer Logic [MLL], which was developed by Setsuo Ohsuga and Hiroyuki Yamauchi, is used as a knowledge representation language. The proposed object-oriented approach was used as a basis for developing the KM [conceptual model] system. The KM system, which was developed at the Applied Mathematics Department of Moscow Power Engineering Institute, is a software system designed to support the construction of the conceptual model of a subject area. The system takes an object-oriented approach to modeling a subject area that assumes the identification of hierarchies of succession (IS-A) and subordination (Part-of) in classes of objects constituting a given subject area. The KM system includes four subsystems as follows: a subsystem for managing models of different subject areas, a subsystem for supporting modeling of a selected subject area, a visualization subsystem, and a printing subsystem that can output models to a file or to a printer. The KM system has been implemented in the languages C and Engine, and its operation requires MS DOS (Versions 3.0 or higher) and 224 kbytes of memory for the load module. Figure 1; references 5: 3 Russian, 2 Western.

Concept of a Document Information System Based on an Object-Oriented Subject-Area Model

947G0028A Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian No 2, Mar-Apr 94 (manuscript received 8 Nov 93) pp 25-32

[Article by Ye.V. Boldyreva, V.S. Galchenko, and E.Z. Lyubimskiy, Applied Mathematics Institute imeni M.V. Keldysh, Russian Academy of Sciences; UDC 683.06.03]

[Abstract] An object-oriented model has been proposed that makes it possible to solve the problem of coordinated management of semantically linked data in different collections of information, as well as to make the information accessible to persons who do not know the collection's structure. The model was developed for document-oriented information systems at administrative bodies where the document is the main unit of information storage and where a document's individual components are used as identifiers for retrieving it. The model, which was designed with consideration for the fact that the objects within the domain of administrative bodies may not only appear and disappear but also divide, merge, and change their name, is structured in the form of a system-directory containing both current and archive information. This approach makes it possible to avoid redundancy and desynchronization of values and to increase the accuracy and currency of information. The model includes the concepts of type of object, copies of objects, and tuples (finite sets of named simple and possibly diverse values). The model allows for three types of multiple values: unmodifiable, augmentable, and modifiable sets. In the model, relations between objects are expressed by using objects' names as attribute values (simple values, elements of tuples, and elements of sets). Thus, a user viewing some object sees not just the features characterizing the given object in isolation, but also its relation to other objects. The model makes it easy to view an object related to a given object and also makes it possible to link objects into hierarchical networks. The system-directory includes (1) objects that may be termed integrated in that they integrate in themselves properties of interest to users of different information collections and (2) local objects, which is a term used to denote objectives in the model of a given subject area as they exist in the local conception of a user of some one information collection. The model does not impose any restrictions with regard to the physical location of information. In other words, information about objects may be stored in both the directory and in the documents of the information collection. Each attribute of a local object bears one of four relationships to the corresponding attribute of its counterpart integrated object: information component, projection, duplicate, or alternative. The administrator managing the directory is responsible for fixing the single source of standard values for each feature of an integrated object. The sole source can be either the system-directory or one of the information collections; the

main thing is that there be just one authoritative source. Because the domain of administrative bodies is such that objects in it may undergo name or type changes (i.e., an enterprise may change its name or type of activity), the system-directory offers the following possibilities for accessing retrospective information: retrieving the values of a specified attribute of a specified object at some specified moment in time, retrieving the previous value of some attribute with respect to the present moment or to an already-located retrospective value; indicating the object in its entirety at some specified moment in time; indicating the previous state of some object; issuing information regarding the time of existence of an already-located retrospective value of an attribute or the time of existence of each of the attributes of the object's retrospective state indicated to the user; issuing information about all objects before and after the specified object in the specified hierarchy at a specified moment in time or at the moment in time preceding the current moment; and user-controlled viewing of some hierarchy of objects at a specified moment in time with the possibility of viewing the objects themselves. Because one of the primary objectives in designing the object model was to make the information management system accessible to persons who know the given subject area but who do not know how information is distributed throughout the information collections constituting the information management system, the model-directory was structured so as to act as a catalogue of the information system. Information in the system may be accessed by a menu-oriented interactive system with a friendly interface called an object-oriented guide.

Parallel Calculations in an Algorithm To Visualize 3-D Objects Constructed Using the Constructive Geometry Method

947G0032 Moscow PROGRAMMIROVANIYE in Russian No 2, Feb 94 (manuscript received 26 Feb 92) pp 16-26

[Article by S. B. Belov, V. A. Bobkov, V. P. May, Yu. I. Ronshin, Institute of Automation and Control Processes, Far Eastern Division, Russian Academy of Sciences; UDC 681.3.06]

[Abstract] Testing results and an effectiveness estimate are presented for parallel processing of graphic information using a transputer computing network in a system to construct and realistically visualize three-dimensional objects constructed using constructive geometry. Objects are constructed using geometric primitives. The number of transputers needed to output an image in real time is 32. The output is 25 frames per second with an image output time of 0.04 seconds. The network is built into an IBM PC AT with a G170 graphic controller. A brief description of the construction method and the object visualization algorithm is given, as well as an evaluation of the complexity of objects created with a system of three-dimensional scenes. Parallel processing of graphic information is the focus of the paper. The visualization algorithm uses calculation of the z-buffer for each line of the raster image. The screen is divided into horizontal bands, as this is more efficient than division into vertical bands. The three dimensional determination of the z distance is reduced to a two-dimensional problem. Paralleling is done on several levels. Figures 2; tables 3; references 4 (Russian).

Fractal Image Compression with the Barnsley -Sloan Method

947G0034 Moscow AVT OMATIKA I TELEMEKHANIKA in Russian No 5, May 94 (manuscript received 8 Jul 93) pp 12-20

[Article by V. A. Bondarenko, V. L. Dolnikov, Yaroslav State University; UDC 517.977]

[Abstract] The mathematical concepts and assertions that form the basis for the Barnsley-Sloan method of fractal compression of graphic information are presented. The Barnsley-Sloan method makes it possible to compress graphic information by a factor of about 500-1000. An original proof of the main theorems is presented, as well as a brief overview of the results as they apply to implementation of the method. The Barnsley-Sloan concept of a frame, a complete compact metric space, is explained mathematically. Frame coding is outlined. Several approaches to the implementation of fractal compression are presented. Russia has only obtained advertising or descriptive literature on this subject; this paper seeks to provide a mathematical introduction and popularize this method. References 18: 11 Russian, 7 Western.

Moscow Symposium Devoted to Software Piracy Issues

947G0035A Moscow KOMMERSANT-DAILY in Russian 24 Jun 94 p 4

[Article by Aleksandr Malyutin under the "Conference on Protection of Intellectual Property" rubric: "U.S. Businessmen Count on Millions"; first paragraph is boldface KOMMERSANT-DAILY introduction]

[Text] **The 3-day international symposium on practical achievement of authors' rights ended in Moscow yesterday. Representatives of many interested Russian governmental organizations, the World Organization for Intellectual Property, and commercial firms took part in it. A conference about the problem of computer piracy was held within the framework of the symposium.**

Those of the world's leading software manufacturers that have entered the Russian market are now deeply concerned about the fact that "nearly all computer programs used by Russian have been acquired illegally." According to World Organization for Intellectual Property data, American firms' losses in Russia alone are estimated at $444 million each year. In addition to explanatory work of the "it is bad to steal" type (which is little effective), the Americans are prepared to resort to a set of measures that have been previously tried in Eastern Europe. At yesterday's conference, Microsoft representative Eric Koenig used a documentary video to graphically demonstrate what happened with one firm (in Czechoslovakia) suspected of computer piracy. The police break into the office, pull employees from their computers, and then have technical specialists verify the legitimacy of all programs found on their hard disks and diskettes. Next comes the court proceedings, as a result of which the guilty parties

pay fines. It has not yet come to this in Russia; however, Robert Clough, head of Microsoft's Russian representatives, announced that a precedent is possible as early as this year.

It should be noted that in addition to righteous indignation at piracy in Moscow computer circles, there is the opinion that foreign firms simply do not know how do business in Russia, they want to increase their "weak sales volumes" with the help of the police, and the level of Russian piracy (according to data from the association BSA, 98 percent of all programs are stolen) has been clearly inflated. Mr. Koenig states, "Whether it is 98 percent or 93 percent is unimportant. No matter which, it does not allow us to make a profit sufficient for reinvestment."

In reality, it is very important to be exact here. Otherwise, extremely extraordinary results will follow from the figures presented. If, for example, you believe the figures of $444 million and 98 percent, then the yearly volume of legal sales in Russia of the software of all American firms taken together does not exceed $9 million. But, as Clough once noted, Microsoft alone invests $10-$15 million in Russia each year. And so it would turn out that the firm that is astronomically profitable throughout the entire world has been enduring massive losses in Russia for more than a year already.

The directors of two Moscow firms producing popular software products in Russia shared their attitude about the problem of computer piracy.

- Yevgeniy Veselov, technical director of the firm Mikroinform (producers of Leksikon, the latest version of which is not protected against copying and which has a monthly sales volume of 1,000 to 3,000 copies, stated the following: "We absolutely support foreign firms' efforts to halt piracy, although our position here is more neutral. I do not believe that this problem should be hard-pedaled. Of course, many people steel. It is not because they have a natural tendency to do so, but even I have a hard time explaining why they steal....Most likely, it is a habit that comes from the old days. We hope, however, that in time, there will be more rich (in the broad sense of the word) people in Russia, and then the piracy will decrease."
- Vitaliy Afanasyev, deputy director of the firm 1S (1S: Bookkeeping is a protected product with monthly sales of 4,000 copies) states the following: "Without a doubt, commercial software products should be purchased rather than recopied surreptitiously. And we are trying in every way possible to promote this idea. But it is not yet particularly popular among users. We therefore consider it necessary to protect our products from unauthorized copying; otherwise, we risk incurring big losses."

Russian Microelectronics Industry Making Progress

947K0074A Moscow DELOVOY MIR in Russian 15 Mar 94 p 5

[Article by Maksim Bashin, doctor of economic sciences: "Russian Microelectronics: Not All That Hopeless"]

[Text] At the international conference "The Future of Microelectronics" held a few years ago, our delegate asked a Japanese specialist: "When will we catch up with the leading nations?" The answer: "Never. You let the opportune time pass by you completely, and we are gaining in superiority." The chronic lag of the Soviet electronics industry behind developed nations was all too obvious.

For years we have been reaping the bitter fruits of a big strategic miscalculation made by the directorate of the USSR Ministry of the Electronics Industry, taking on faith the predictions of the sector big brains. Predictions are a risky business in science. Especially when they are made by amateurs. The officials ignored obvious facts that confirmed the approach of a new era in electronics.

In defiance of their assumptions, within a few years there was a breakthrough in the component base: LSI (large-scale integrated) chips, followed by VLSI (very large-scale integrated) chips. A very complicated engineering problem had been solved: packing the maximum of performable technological functions into subminiature volume and weight.

A basic goal of prediction is not just to foreshadow, but also to keep higher authorities from making wrong decisions, to mark ways of eliminating unfortunate consequences, to utilize discovered prospects to maximum effect. This is the path that has been taken by companies in industrially developed nations. By concentrating resources, they have achieved impressive engineering and commercial results in a short time.

Soviet microelectronics was dependent on import, but the ministry continued to have faith in the complete competitiveness of our goods. Every year, specialists of the Ministry of the Electronics Industry prepared overviews for the Council of Ministers and sector divisions of the CPSU Central Committee about correspondence of produced goods to the world level. There was no sparing of glowing terms; the careers of those writing these reports depended on them.

During the Cold War, NATO instituted a strict embargo on export of strategic and high-tech items to the USSR. The KOKOM list included microelectronics.

Extreme measures had to be taken to ensure reliable defense. Using its special position, the VPK [All-Union Industrial Office] provided the component base for the needs of producing many kinds of armament without counting the cost. Therefore, prices for electronic components exceeded the world average by four orders of magnitude. The public purse paid lavishly for State orders and unlimited funding.

But we mustn't rehash old failures. It is more important to assess the actual level of Russian microelectronics at the beginning of 1994. Not everything is as hopeless as some analysts assume. A kind of "light at the end of the tunnel" has appeared. Let's look at the facts.

The IVK Joint Stock Company has been set up in Russia with capital of about 50 million dollars. Cooperation with the "Kvant" Plant has brought the advent of a promising line of world class computers. The production capacity of the plant is 100,000 units per year. The achievements of the partners, who work in many areas of electronics, is tied up with the growing Russian computer market. According to expert estimates, "Kvant's" annual sales volume is upwards of a billion dollars.

The "Kvant" Plant is considered to be the standard for enterprises of the sector. Provided with modern equipment, well supported technologically, it has the versatility to convert to a constantly changing range of products. The infrastructure of the company is also getting stronger. Some resources are diverted to purchase of component items. A solution is also being found for the complicated problem of reducing the cost of factory units by 40-50 percent, which will lower wholesale factory prices by 15-20 percent.

In 1993, the IVK Joint Stock Company successfully entered the Southeast Asian market. Exported chips have been well received, and sales volume is increasing. Plans are being made to produce the latest competitive models of television sets.

Telephones—IVK Joint Stock Company: (095)284-33-35, "Kvant" Plant: (095)534-06-36, 284-88-39.

The "Minifab" Joint Stock Company has mastered production of specialized microchips (SPIS). These selectively perform certain technological functions with high precision, reliability, and economy of resources. They are priced much lower than LSI and VLSI chips. The principal consumers are VPK enterprises and many entrepreneurial structures that utilize the high-tech and economy characteristics of the innovation.

Development of SPIS technology initiates a second (after the advent of microprocessors) revolution in microelectronics, and the demand for them is growing at an accelerated pace. Therefore, the "Minifab-1" complex has been instituted to produce SPIS, and work on the "Minifab-2" complex continues. It is oriented toward production of goods with better characteristics. Creation of SPIS is based on leading advances by Soviet scientists in the field of laserography.

The beginning of 1994 was marked for the joint stock company by commercial activity in nations of Western Europe. "Minifab" solicits extensive cooperation of Russian and foreign investors who make use of SPIS and the latest laser technologies.

Telephone (095)531-10-63.

The "Silena" Company in cooperation with instrument makers of the Moscow suburb of Lytkarino is venturing into active marketing and subsequent export of ultrapure chip silicon. Miniature disks of silicon chips sell for 250-300 dollars apiece. It is important that in the near future these items will become a base for development of twenty-first century computers. "Silena" also has unique technologies

for production of fundamentally new classes of solar batteries for satellite systems, battery-powered vehicles and a wide range of household appliances. The accumulated scientific- technical potential is protected by a set of patents and know-how. Some goods are being sold in Germany.

(095)555-44-27, 555-42-88.

The Scientific Research Institute of Electronic Technology is successfully operating on the market in cooperation with the "Mikron" Plant. About half of its output is exported. Talks are being concluded with electronics companies of China about sending high technologies there.

The Chinese are also eagerly buying unique technological equipment produced by the "Elion" Plant for making modern microelectronic equipment.

Telephone (095)531-23-60.

The "Aviation Electronics" Joint Stock Company specializes in production of complicated electronic aerospace systems. The demand for these is increasing on both domestic and foreign markets.

All this is a far from complete list of organizations and companies that are successfully dealing with complicated scientific production problems. Let us add that construction is being completed in Zelenograd on yet another large plant oriented toward production of the latest microelectronics.

By invitation of the U.S. Commerce Department, specialists of the State Committee on Defense Sectors of Industry visited the famous Silicon Valley (California) in February. They familiarized themselves with U.S. businesses that use up-to-date technology. The visit resulted in a decision approved by the RF government on the "Mikron" Plant's acquisition of a franchise for producing RISK- processors according to technology of the SUN Company. Bilateral cooperation is being arranged between U.S. and Russian companies. It cannot be ruled out that in a few years the industrial zone of the Moscow suburb of Zelenograd and Silicon Valley (California), where the microelectronics industries of the two nations are concentrated, may become adopted brothers.

Let us now return to the severe condemnation of the Japanese specialist. It is quite apparent that his response included three components: the triumph of victors, premeditated promulgation, and ... a kind of extrasensory effect of insinuation. But how often predictions turn out to be erroneous!

Today we are seeing a clear trend: in major areas of Russian microelectronics, islets of scientific-technical progress are actively forming, where high scientific and commercial results have been attained. The old lag behind developed nations is gradually being eliminated. The capacious and far from fulfilled potential of Russia is being realized. And that is just the beginning.

The final breakthrough in technology will require protracted efforts and major investments. And, alas, we know how complicated that can be.

Foreign partners are endeavoring to use the difficult situation to their advantage. The chief engineer of an electronics plant, Nikolay Yermolayev, has on his desk a stack of business cards of specialists and directors of reputable Western companies. As he shuffles them, he says: "Not a single realistic deal. They come up with unacceptable, and at times humiliating demands."

Legislative regulation of innovative processes in the RF is still fragmentary, and repels investors, especially foreign investors.

The spontaneous nature of defense conversion and failed attempts to diversify production have put many enterprises of the sector on the verge of bankruptcy. Almost all producers of goods are turning their efforts toward increasing export. This is the only real opportunity for surviving the hard conditions of converting to a market economy.

One more problem. The U.S. administration has promised to repeal the embargo of export of goods to Russia in accordance with the KOKOM list before 31 March 1994.

The complicated political relations between the two countries in our opinion may lead to some adjustment of times. Influential circles of the United States feel that achievement of balanced decisions between Moscow and Washington will be difficult, but at the same time the beginning cooperation between the two nations inspires optimism.

But there are negative signals as well. In the course of contacts already arranged with some U.S. companies, attempts are being more and more frequently made to foist off unpromising or ecologically dirty technologies on Russian enterprises. Extreme situations may also arise. Therefore we must continually strengthen and expand our own scientific and production potential in microelectronics. The more so as Russian specialists do have opportunities for accomplishing this.

Telephone (095)373-88-62.

Structure of Conduction Band in InAsSbP Solid Solution

947K0085A St.Petersburg FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 27 Nos 11-12, Nov-Dec 93 (manuscript received and signed to press 6 Jul 93) pp 1777-1787

[Article by T.I. Voronina, T.S. Lagunova, K.D. Moiseyev, M.A. Sipovskaya, I.N. Timchenko, and Yu.P. Yakovleva, Institute of Engineering Physics imeni A.F. Ioffe at Russian Academy of Sciences, St.Petersburg]

[Abstract] A comprehensive experimental study of the $InAs_{0.62}$ $Sb_{0.12}P_{0.26}$ material was made concerning its conduction band, this and other materials in the $InAs_{1-x-y}$ Sb_yP_x series of solid solutions being used for lasers, light-emitting diodes, and photodetectors. Eight specimens of 3 μm thick epitaxial layers were grown from the liquid phase at a 550°C temperature on semi-insulating p-InAs substrates at a 77 K temperature, with a hole concentration $p = 10^{14}$ cm^{-3} and an electrical resistivity $\rho = 100$ Ω.cm. They were doped with In + 3% Te alloy. Their electrical conductivity, Hall coefficient, and transverse magnetoresistivity

were measured at temperatures covering the 4.2-77 K range in a magnetic field of up to 10 kOe intensity. Their longitudinal magnetoresistivity was measured at temperatures covering the 4.2-16 K range in a magnetic field of up to 50 kOe intensity. Their photoconductivity spectrum was measured at 77 K. Following an analysis of the Shubnikov-de Haas effect in strongly degenerate specimens at liquid-helium temperature, the effective mass of current carriers in this material is estimated most precisely on the basis of cyclotron resonance data. The changing effective mass of current carriers whose concentration is known has also been estimated from the wavelength of maximum photoconductivity in the spectra of specimens with differing hole concentrations. Data on electron mobility $\mu = \sigma R$ (σ- electrical conductivity, R- Hall coefficient) are used for estimating the effective mass of electrons in n-InAsSbP solid solutions. The subsequently calculated dependence of $(dE/dk)_F$ and electron energy in the conduction band on the wave vector k is found to be a nonparabolical one, its deviation from a parabolical one agreeing with Kane's theory for narrow-band $A^{III}B^{V}$ semiconductors and the energy dispersion fitting the two-band approximation of that theory. Figures 8; tables 4; references 9.

Photodiodes on Metal-Semiconductor-Metal Structures with Low Dark- Current Density

947K0085B St.Petersburg FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 27 Nos 11-12, Nov-Dec 93 (manuscript received and signed to press 30 Apr 93) pp 1811-1814

[Article by S.V. Averin, V.T. Potapov, and A.N. Tsarev, Institute of Radio Engineering and Electronics, Fryazino; S.V. Novikov and Yu.V. Shmartsev (deceased), Institute of Engineering Physics imeni A.F. Ioffe at Russian Academy of Sciences, St.Petersburg; A. Meskida- Kuesters and K. Heime, Institute of Semiconductor Electronics, Aachen/ GERMANY]

[Abstract] An experimental study was made concerning the feasibility of lowering the dark current in Schottky barriers of a metal-semiconductor- metal (MSM) photodiode structure and thus increase the sensitivity of a photodetector with a pair of such barriers connected in opposition, the noise in such a device and thus also its sensitivity being determined by the recerse current in one of the barriers. Epitaxial GaAs layers with a low dislocation density and a low residual impurity concentration were grown from the liquid phase on semi-insulating GaAs(100) substrates, a GaAs:Bi melt being formed by dissolving GaAs in pure bismuth. The temperature during epitaxy was being lowered from the initial 800°C in 50°C steps at a rate of about 0.5°C/min each time. The amount of hydrogen passing through the reactor was maintained at a constant level of about 5 l/h, electronic flow rate regulators being used for this purpose. Thus were formed 5 μm thick GaAs:Bi layers with a charge carrier concentration from $N_D = 2 \times 10^{14}$ cm^{-3} up and a carrier mobility not exceeding 7.7 $kV.cm^2/s$. A comb structure of 0.3 μm thick and 5 μ wide Ti-Pt-Au Schottky barriers 5 μm apart serving as electrodes, five pairs of them in an array with a 100 μm wide aperture, was formed on the surface of each GaAs:Bi layer by contact photolithography. The dark current in these MSM photodiodes was measured at bias voltages up to avalanche breakdown. It began leveling at about 1 V and continued rising slightly to about 0.5 nA at 6 V, precipitous avalanche breakdown occurring only at about 30 V. A signal from these photodiodes was a peaking pulse 58 ps wide at 50% amplitude with a 43 ps rise time, followed by fast decaying oscillations. The photosensitivity spectrum of these photodiodes covered the 0.6-0.9 μm band with maximum sensitivity to 0.85 μm radiation. For comparison, conventional MSM photodiode structures were built with epitaxial pure GaAs layers on semi-insulating GaAs substrates. Their dark current was consistently much higher throughout the entire voltage range, about 50 nA at 6 V, "mild" avalanche breakdown occurring already at 20 V. Figures 3; references 11.

Intense Luminescence in Porous Silicon

947K0085C St.Petersburg FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 27 Nos 11-12, Nov-Dec 93 (manuscript received and signed to press 14 May 93) pp 1815-1819

[Article by L.V. Belyakov, D.N. Goryachev, O.M. Sreseli, and I.D. Yaroshetskiy, Institute of Engineering Physics imeni A.F. Ioffe at Russian Academy of Sciences, St. Petersburg]

[Abstract] An experimental study of electroluminescence in porous silicon wetted by solutions of various oxidizers was made, films of porous silicon having been produced on the surface of n-Si(100):P (electrical resistivity 2 Ω.cm) by its anodization with a water-alcohol HF solution at a current density within 10-15 mA/cm^2 for 0.5-10 min. The films, with brilliant surface and strong bond to the substrate, were in the process illuminated by a light beam from an incandescent lamp. They were then held in contact with solutions of strong oxidizers, 0.1-0.2 N H_2 H_2 or 0.1-0.2 N $K_2S_2O_8$ with 1.0 N H_2SO_4 as supporting electrolyte, while a voltage negative with respect to a Pt counterelectrode was being applied to them. Application of not only a constant voltage or of voltage pulses but also of a sinusoidal voltage alternating at frequencies up to 200 Hz gave rise to electroluminescence, current rectification evidently taking place in the latter case by diode action of the semiconductor-electrolyte interface. The photoluminescence spectrum extended over the 550-800 nm range with the maximum-intensity wavelength somewhat shorter than 700 nm upon excitation by 440 nm light. The electroluminescence spectrum extended over the 550-900 nm range with the maximum-intensity wavelength about 700 nm upon excitation by an electric current of 20 mA/cm^2 in the H_2O_2 + H_2SO_4 electrolyte. Also the capacitance of the Si(por)-electrolyte contact was measured, for a study of its transient behavior. With no current flowing, it was found to decrease from about 50 μF to a somewhat below 25 μF threshold level within 80 min. With a current of 30 mA/cm^2 density flowing, it was found to increase from below 25 μF to an about 50 μF saturation level within 16 min. The experimental data, the mechanism of the Si + $2H_2O_2 \rightarrow SiO_2 + 2H_2O$ reaction, and the structure of energy levels in each reactant indicate the feasibility of

producing effective Si(por) light-emitting diodes by efficient injection of minority charge carriers into this semiconductor. Figures 3; references 10.

Temperature Dependence of Steady-State Visible Photoluminescence in Porous Silicon

947K0085D St.Petersburg FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 27 Nos 11-12, Nov-Dec 93 (manuscript received 16 Jun 93, signed to press 21 Jun 93) pp 1846-1850

[Article by A.A, Lebedev, A.D. Remenyuk, and Yu.V. Rud, Institute of Engineering Physics imeni A.F. Ioffe at Russian Academy of Sciences, St.Petersburg]

[Abstract] An experimental study was made concerning the temperature dependence of visible photoluminescence in porous silicon, intensity measurements being made at temperatures covering the 77-440 K range. Porous silicon was produced by anodization of Si(111) or Si(100) single-crystal plates (electrical resistivity 10 Ω.cm) with HF solution at current densities of 5-80 mA/cm^2 for 15-40 min, 10 μm thick Si(por) films then being excited by an ILA-120-1 "Karl Zeiss" Ar-laser. The laser beam power was varied over the 1-50 mW range and the excitation intensity correspondingly over the 10^{20}-10^{22} quanta/cm^3 .s range within a 0.01 cm^2 light spot area. At room temperature the spectrum was about 1.25-2.25 eV wide with the maximum- intensity wavelength within 670-700 nm. As the temperature was raised from 77 K to 440 K, the spectrum was becoming slightly narrower with the quantum energy decreasing and the maximum intensity shifting to longer waves. Figures 4; references 7.

Kinetics of Structural Defectiveness in Thermally Oxidized Silicon Layer

947K0085E St.Petersburg FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 27 Nos 11-12, Nov-Dec 93 (manuscript received 12 Jul 91, signed to press 28 Jun 93) pp 1851-1856

[Article by V.P. Shapovalov, V.I/ Gryadun, and V.P. Tokarev, Institute of Machine Construction imeni V.Ya. Chubar, Zaporozhye/UKRAINE

[Abstract] An experimental study has revealed that number of structural defects in the Si boundary layer at the Si-SiO_2 interface does not increase monotonically with increasing thickness of the SiO_2 coating but depends on its thickness much more intricately. In the experiment n-Si(111):P slices with an N_P= $5x10^{16}$ phosphorus concentration were oxidized in H_2O + 4% HCl vapor at 1000°C temperature for 4-360 min. Microstructural examination yielded a pattern of the dislocation surface density climbing to a wide peak under 0.15-3.5 μm thick oxide films, then falling to a narrow valley under about 4.5-5.5 μm thick oxide films, and then climb again to a saturation level under still thicker oxide films. This trend is explained theoretically by analysis of microdefectiveness kinetics at the interface during the initial few stages of oxide film buildup, the evidently fast structural degradation being associated with three processes: 1. migration of silicon atoms into interstitial vacancies 2. diffusion of oxygen into silicon and its accumulation at the interface 3. buildup of elastic shear stresses of the order of 10 GPa magnitude in the Si-SiO_2 system due to incongruity of Si and SiO_2 volumes and their subsequent relaxation at a rate depending on the oxidation rate. The initial density C_0 of microdefects at the Si-SiO_2 interface is calculated on theoretical expressions with empirical constants describing these three processes. The subsequent density C_c of silicon (V) clusters in interstitial vacancies and density C_d of dislocations forming in silicon during lengthy thermal oxidation, both depending on the oxide film thickness x, are each calculated by solution of the corresponding system of two linear first-order ordinary differential equations: dC_c/dx = ..., dC_v/dx = ... for the clusters (C_v-concentration of vacancies in silicon boundary layer) and dC_c/dx =..., dC_d/dx = ...for the dislocations. The results indicate an about 10 μm distance between microdefects, about 100 silicon atoms in an interstitial cluster, and an approximately $4x10_5$ cm^{-2} dislocation density. Figures 2; references 11.

New Types of Solar Cells Using Structures with Variable Energy Gap Width

947K0085F St.Petersburg FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 27 No 11-12, Nov-Dec 93 (manuscript received 8 Jul 93, signed to press 9 Jul 93) pp 1924-1930

[Article by Yu.T. Rebane and Yu.G. Shreter, Institute of Engineering Physics imeni A.F. Ioffe at Russian Academy of Sciences, St.Petersburg]

[Abstract] Two new types of solar cells are considered, both using semiconductor structures with a variable energy gap width. In the cells of the first type charge carriers generated by photoexcitation are separated by a magnetic field. The operating principle of these solar cells is based on semiconductor and circuit theories, all four components of the conductivity tensor being represented in accordance with the Hall effect theory for an isotropic material. Their ideal efficiency efficiency, taking into account thermal effects in accordance with Einstein's relation, approaches the thermodynamic limit $\eta = 1 - TS/E < 1$ (T- absolute temperature, S- entropy, E- energy of incident light) in a sufficiently strong magnetic field when the nondiagonal $\sigma_{xy,yx}$ components of the two electron and hole magnetoconductivity tensors are respectively equal. In cells of the second type the semiconductor is doped in a pattern of differently oriented parallel arrays of n-type conducting strands and parallel arrays of p-type conducting strands will form, separation of charge carriers being thus effected without a magnetic field. The operating principle of these solar cells is based on the same theories, with correction for anisotropy of the material and absence of a magnetic field. Their ideal efficiency at zero absolute temperature is $\eta = 1 - \delta V/V_0$ and thus approaches 1.0 when $\delta V = V_0 - V \rightarrow 0$ (V- applied voltage, $V_0 = L_y \delta E_g/dy$, L_y-width of cell structure, $\delta E_g/\delta y$ - transverse gradient of energy gap width). At higher temperatures their efficiency is $\eta(1 - TS/E)$. Solar cells of the first type are of no practical interest, but those of the second type will be when a method of forming mutually orthogonal arrays of n-type and p-type strands has been devised. Figures 2; references 3.

Role of Light in Formation of Porous Silicon on P-Type Substrates

947K0085G St.Petersburg FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 27 Nos 11-12, Nov-Dec 93 (manuscript received and signed to press 12 Jul 93) pp 1961-1964

[Article by L.V. Belyakov, D.N. Goryachev, O.M. Sreseli, and I.D. Yaroshetskiy, Institute of Engineering Physics imeni A.F. Ioffe at Russian Academy of Sciences, St. Petersburg]

[Abstract] The effect of light on formation of porous silicon on p-Si substrates during their anodization is HF solutions, this being the most effectively used method of their formation. The analysis of this process considers the role of light in formation of electron-hole pairs during the $Si + 2h^+ + 6HF \rightarrow (SiF_6)^{2-} + H_2 + 4H^+$ reaction. Experiments have revealed that Si(por) films form with and without illumination, but that their structure will be different, and that illumination during anodization does not shift the electrode potential of p-Si so that the electrolyzer voltage need not be adjusted for maintaining the current density. Uniform illumination of the surface noticeably influenced its appearance by changing its color from dark gray or black to light green-blue or yellow-blue. The surface of thicker than 10 μm layers became friable and dull, an orange powder covering it when the anodization treatment was prolonged. Illumination during anodization increased the intensity of subsequent photoluminescence by about one order of magnitude and shifted the photoluminescence spectrum into the blue region. Nonuniform illumination during anodization caused the thickness of Si(por) films to increase from 2-3 μm in the dark to 10-20 μm maximum at a distance within 100-500 μm from the light spot and then decrease to near zero directly under the light spot. These experimental findings are are explained by the mechanisms of the electrochemical reaction proceeding in two successive stages at the semiconductor-electrolyte interface: 1. $Si + 2h^+ + 2HF \rightarrow SiF_2 + 2H^+$ 2. $SiF_2 + 4HF \rightarrow (SiF_6)^{2-} + 2H^+$ with simultaneous transfer of charges from the substrate: holes from its valence band $Si^{2+} + 2h^+ \rightarrow Si^{4+}$ and electrons from its conduction band $2H^+ + 2e^- \rightarrow H_2$ or $2SiF_2 + 2HF \rightarrow Si + (SiF_6)^{2-} + 2H^+$ with simultaneous transfer of substrate holes $Si^{2+} + 2h^+ \rightarrow Si^4$ and of substrate electrons $Si^{2+} + 2e^- \rightarrow Si$ References 11.

Inverse Population of Spatial Quantization Levels in Two-Dimensional InAs/AlSb/GaSb Systems

947K0085H St.Petersburg FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 27 Nos 11-12, Nov-Dec 93 (manuscript received 12 Jul 93, signed to press 13 Jul 93) pp 1990-1994

[Article by Yu.B. Vasilyev and S.D. Suchalkin, Institute of Engineering Physics imeni A.F. Ioffe, St.Petersburg]

[Abstract] Intersubband transitions in InAs/AlSb/GaSb structures are analyzed for the possibility of laser transitions in the quantum well of these structures. A tunnel diode of this type consists of an InAs quantum well between an AlSb potential barrier and a GaSb heterojunction, with strongly doped n'-InAs emitter and p'-GaSb collector regions. The quantum well is assumed to contain only two energy levels, the the upper one and the lower one corresponding respectively to the forbidden band and the valence band in the heterojunction. Such a configuration is necessary for population inversion to occur upon application of a voltage of appropriate polarity to the potential barrier so that electrons upon tunneling through the potential barrier will be injected into the quantum well onto the upper level. Blocked by the forbidden band in the heterojunction and their tunneling from the upper level int the collector cut off, electrons can then reach the collector only by first descending to the lower level. Transition of electrons from upper level to lower level can be effected either by their scattering or by emission of photons. The performance characteristics of such a laser, its gain and relaxation time, are calculated theoretically by using the density matrix of a two-level system. In this formulation the gain $g(\lambda)$ is proportional to the inverse population $\Delta N = N(2) - N(1) \approx JT/e$ (J- current density, T- nonradiative recombination time, e- electron charge) and to the wavelength λ squared, inversely proportional to the spontaneous radiative recombination time τ and to the refractive index n, and more intricately dependent on the nonradiative recombination time T. The emission spectrum is shown to cover the 400-600 nm range of wavelength with a narrow peak about the 500 nm maximum-gain wavelength: $\alpha > 800\ cm^{-1}$ when the current density $J = 10\ kA/cm^2$ and intersubband energy is $E_{12} = 22$ meV. Figures 2; references 15.

Role of Oxygen in Instability of Carbonic Radiative Defects in Silicon

947K0085I St.Petersburg FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 27 Nos 11-12, Nov-Dec 93 (manuscript received and signed to press 13 Jul 93) pp 2068-2074

[Article by Ye.M. Verbitskaya, V.K. Yeremin, A.M. Ivanov, N.B. Strokan, S. Lee , and B. Schmidt, Institute of Engineering Physics imeni A.F. Ioffe at R ssian Academy of Sciences, St.Petersburg]

[Abstract] An experimental study was made concerning restructurization of the energy spectrum of carbonic defects in high-resistivity silicon detector crystals grown by the floating-zone (FZ) method. The main concern was the possible effect of oxygen on the dynamics of that restructurization process, considering that both carbon and oxygen concentrations in such crystals are 1-2 orders of magnitude lower than in crystals grown by the Czochralski (CZ) method. Detectors for the experiment were built using p'-n-n' FZ-n-Si crystals with an electrical resistivity of 5 kΩ.cm (Wacker Chemitronics) and 1-2 kΩ.cm (Spuremetalle Freiberg). They were produced by the planar technology and passivation of the p'-n junction with an oxide film, p' and n regions having been formed by implantation of boron B+ and phosphorus P+ respectively. The spectrum of deep levels was measured by the DLTS method at a frequency of 100 kHz at a $(41.7\ ms)^{-1}$ window, radiative defects in the p' region being induced by injecting into it a flux of $10^9\ cm^{-2}$ α-particles at a temperature about 180 K. The electron emission spectrum of these detectors was found to contain three carbonic defect levels E1,E2,E3 before injection of α-particles and to

acquire two defect levels H1 (interstitial carbon), H2 (interstitial carbon and interstitial oxygen) during injection. It has also been found that annealing the H1 defects, which was done isothermally at 19°C and 50°C, is attended by enhancement of the H2 defects. The dependence of the emission spectrum on the length of annealing time was obtained by recording it during annealing immediately after injection and then successively 2-5-8-15 h later. The temperature dependence of the emission spectrum was obtained by recording it at temperatures from 77 K to about 220 K. The experiment revealed no significant differences between the effects of α injection on FZ-Si and CZ-Si detectors. The mechanism of H1 annealing and attendant H2 enhancement is interpreted by regarding the radiation-stimulated formation of carbonic C(i)-C(s) complexes in silicon (i- interstitial carbon, s- carbon in lattice node) as a Si(i) +C(s) → C(i) + Si(s)(H1 defect) reaction and the C(i) annealing process as a set of three reactions: C(i) + O(i) → C(i)-O(i) = H2 defect, C(i) + C(s) → C(i)-C(s) = E2 defect, C(i) + P(s) → C(i)-P(s). Figures 5; tables 2; references 15.

Quasicollimators

947K0088A Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian No 2, Feb 94 (manuscript received 1 Jul 92) pp 177-184

[Article by V. A. Torgovanov; UDC 621.396.677.49: 681.777]

[Abstract] The author sets forth principles of design of portable and mobile collimators based on antenna arrays with scanned-beam antennas for adjusting and monitoring electronic receiver systems. A modification of these miniature collimators is the quasicollimator, in which a decoupling radio absorbing structure is located much closer than a wavelength to the antenna being tested. The quasicollimator sets up an amplitude-phase distribution typical of a plane wave across the aperture of the antenna. Tests of radio direction finders by quasicollimators in the sector of angles from -60° to +60° in laboratories and under field conditions confirmed measurement accuracy with precision to tenths of a degree. Actual sensitivity could be determined with maximum error from -2 to +2 dB over a wide frequency range, and the productivity of measurements was increased by more than an order of magnitude over conventional techniques. Formulas 2, references 7.

Numerical Method of Analyzing Emission Characteristics of Surface Antenna Located on Polyhedron

947K0088B Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian No 2, Feb 94 (manuscript received 7 Dec 92) pp 228-233

[Article by D. D. Gabrielyan; UDC 621.396.677]

[Abstract] In most cases, calculation of the characteristics of a surface antenna concentrates on two-dimensional cylindrical bodies or solids of revolution. Although an approach has been proposed for calculating the directional pattern of slots on a square plate, the solution is valid only for a large number of radiators and large electrical dimensions of the body. The author of this paper suggests a method of solving the problem of emission of a surface antenna on an ideally conductive polyhedron of arbitrary shape that simplifies calculations. The approach is based on making allowance for the specifics of current density distribution on the surface of the polyhedron. It is shown that the proposed technique considerably reduces the volume of calculations, is accurate enough for practical calculations, and can be broken down into algorithms that are easily translated into a computer program. Figures 3, formulas 12, references 12.

Mathematical Model of Phased-Array Radar Measurements of Angular Coordinates in Problems of Synthesizing Measurement Processing Algorithms

947K0088C Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian No 2, Feb 94 (manuscript received 18 May 93) pp 253-258

[Article by V. N. Vinogradov and G. A. Golubev; UDC 621.396.67]

[Abstract] The authors develop a simple mathematical model of the process of measuring angular coordinates of moving guided and free-flight objects by phased-array radar, and a mathematical model of angular measurement errors. The approach is based on linearizing the actual directional pattern relative to the nominal pattern with respect to errors of the phased array. It is shown that measurement errors are the additive sum of the random linear trend of angular indication coordinates, the deterministic function of the calculated phase increment, and a random process that is also a function of the calculated phase increment. Moment characteristics are determined for random parameters of the trend and the random process. The proposed mathematical models can be used to synthesize algorithms for measurement error compensation and radar alignment in addition to optimizing measurement information processing algorithms. Formulas 37, references 3.

Nonlinear Faraday Effect in Magnetized Electron Beam in Cyclotron Autoresonance, and Bistability in Microwave Devices

947K0088D Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian No 2, Feb 94 (manuscript received 27 Feb 93) pp 309-317

[Article by V. A. Kubarev and V. A. Cherepenin; UDC 6221.385.6]

[Abstract] The authors examine bistability in systems with cyclotron autoresonance for which analytical solutions are known. The base model is a Fabry-Perot resonator with nonlinear medium: a magnetized relativistic electron beam. The system is assumed to be passive. An analysis is made of autoresonant interaction of this initially straight beam with waves moving in the same direction or counter to the beam. This nonlinear Faraday effect can be put to use in nonreciprocal and nonlinear devices with electronic control in the microwave band. In the case of a bistable Fabry-Perot resonator, its state can be switched by microwaves at near-resonant frequency while being "read" by a

signal on another frequency in the region of transparency. And synchronism on two frequencies in the relativistic electron beam enables reciprocal control of signals with very different wavelengths. The results of the study suggest that bistability effects should be a rather general property of both passive and active devices in the microwave band with intense electron beams, especially with oversized electrodynamic systems. Figures 4, formulas 16, references 17.

Design of 'Cylindrical Magnetic Wall' Magnet System Without Magnetic Circuit

947K0088F Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian No 2, Feb 94 (manuscript received 22 Nov 91; after revision 3 Feb 93) pp 327-336

[Article by V. B. Ozeretskovskiy; UDC 537.613.01]

[Abstract] The author sets forth an analytical method and presents results of calculation of a magnet system that is formed by an even number of prismatic oppositely magnetized permanent magnets made of rare earth elements placed on a cylindrical jacket of nonmagnetic material. It is shown how such structures are used in microwave ion sources as containment systems for gas discharge plasma near a wall. Solutions in the form of series of harmonic functions that are suitable for practical calculations are found for scalar magnetic potential, intensity vector flux, and magnetic field strength components. Figures 7, formulas 16, references 7.

Microwave Current-Voltage Characteristics and RF Current Instabilities in Selectively Doped AlGaAs/GaAs Heterostructures

947K0088E Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian No 2, Feb 94 (manuscript received 27 Feb 93) pp 321-327

[Article by V. N. Borisov, S. G. Dmitriyev, V. Ye. Lyubchenko, B. K. Medvedev, V. G. Mokerov, A. S. Rogashkov and K. I. Spiridonov; UDC 537.312.62]

[Abstract] The authors study pulsed and microwave current versus voltage responses in the temperature range of 100-200 K on long (l = 5 mm) specimens based on selectively doped $Al_{0.25}Ga_{0.75}As/GaAs$ heterostructures with dopant concentration of $8x10^{17}$ cm^{-3} used in making transistors with high electron mobility. It is shown that the shunting action of the AlGaAs layer considerably modifies the high-field section of the microwave current-voltage characteristic. Measurements are made of the parameters of RF oscillations observed in the study specimens, and it is shown that charge storage processes in the AlGaAs layer have a considerable effect on the shape and frequency of these oscillations. It is suggested that low field strengths may be due to preswitching of the system to a state with uneven potential distribution, resulting in considerable coverage of the two-dimensional conduction channel. As a whole, the results indicate two-channel behavior of current oscillations. Figures 3, references 8.

Russian Scientists Comment on Semi-conductor Research Accomplishments

947K0090A Novosibirsk SOVETSKAYA SIBIR in Russian 1 Jun 94 p 2

[Interview with I. Neizvestnyy, associate member of the Russian Academy of Sciences, and V. Shumskiy, laboratory chief, by D. Fedorov: "Trash Has Been Seen... in Space"]

[Text] *An excursion through the laboratories was followed by a "round table," where department hosts I. Neizvestnyy and V. Shumskiy acquainted me with their work in more detail.*

The department is engaged in research on a new class of semi-conductors. In particular, these include indium-doped lead- tin-tellurium solid solutions. These materials have shown a number of fundamentally new properties. Among other things, they have high radiation resistance. All this allows them to be treated as a new class of semiconductor materials.

The new materials have some valuable advantages over ordinary semi-conductors. For example, there are regions where the use of silicon devices is limited by their properties, primarily by low sensitivity in certain spectral ranges, especially the infrared. This is basically what prompted the search for new materials. Plus, of course, purely scientific interest. New knowledge has been obtained about the nature of physical phenomena in semiconductor compounds. The experimental and theoretical results attained at the Institute of Semiconductor Physics, and their analysis are original for world science, and the technological base that has been set up and specimens of multiple-cell photodetectors for the far infrared are not only on a par with foreign analogs, but surpass them in some parameters.

This research area has been under development since roughly the mid eighties. Cadmium-mercury-tellurium technology had already been rather well developed at that time. Today there are two alternative directions: cadmium-mercury-tellurium and lead-tin- tellurium. Each of these compounds has its own advantages.

Besides the Institute of Semi-conductor Physics, the greatest contribution to this research in Russia has been made by scientists of Moscow Physics Institute, Moscow State University and St. Petersburg State Technical University. All are working in the closest cooperation, one might say as a team, and it is no accident that scientists from different cities are listed among the authors of competitive work. The role of the Institute of Semiconductor Physics in this work has consisted mainly in the development of technology for producing the material itself and making multiple- cell infrared photodetectors.

Both of my hosts pointed out that modern experimental physics requires the participation of a great many specialists. Not infrequently, a paper is authored by more than ten people. And, of course, not nearly everyone is included among the authors: many people have been at work on various stages of the research, and final results of any value will be obtained only if all have been working in friendship and harmony, as a single organism. And here there can be

no question of the services of group supervisor Aleksandr Klimov, senior scientist and candidate of physical and mathematical sciences. He is a highly skilled specialist in the area of physics of devices and measurement techniques; starting with his dissertation, all of his work has been devoted to study of the lead-tin-tellurium semiconductor compound and development of photodetectors based on it. Also indisputable in formulating the task of developing devices for the far infrared have been the services of institute director Konstantin Konstantinovich Svitashev, associate member of the Russian Academy of Sciences. It is he who attended a semi-conductor conference in Moscow, heard a report by Boris Akimov, a doctor of physical and mathematical sciences from Moscow State University and a pioneer in this research, and was so fascinated by Akimov's ideas that he invited the speaker to Novosibirsk, and actually brought together future claimants for the State Prize... And since we are talking about fountainheads of research, this is a good place to mention that the Institute of Semiconductor Physics itself was set up by its founder, Anatoliy Rzhanov, primarily to study the semiconductor surface and thin films. In the years that followed, he created at the institute a remarkable school of specialists in this area, and put together a high-class pool of instruments and equipment.

It is completely obvious that devices based on the new semi-conductor materials may be used in many industries, but mainly for various kinds of space research. It is here that the highly sensitive devices with far infrared vision will certainly find the widest application. They can be not only of purely scientific, but also of palpably practical benefit. These devices will be truly irreplaceable, for example, in solving a problem that has now become imminent: detection of "space trash." Spent carrier rockets, retired satellites and their fragments, there has been more than enough of this that has accumulated over the decades of the "space age." And the greatest threat is from tiny particles that are hard to detect unless appropriate instruments are available. The fact is that these particles may have a very low temperature, their radiation is in the far infrared region of the spectrum, and they are invisible to ordinary instruments, but not to a keen infrared sensor.

Probability Density Distribution of Background Noise for a Generalized Algorithm To Detect Signals on a Background of Noise

947K00091 Minsk VESTSI AKADEMII NAVUK BELARUSI. SERIYA: FIZIKA-TEKHNICHNYKH NAVUK in Russian No 4 Oct-Dec 93 (manuscript received 12 Jan 93) pp 63-70

[Article by V. P. Tuzlukov, Institute of Technical Cybernetics, Academy of Sciences of Belarus; UDC 621.396:62.019.4]

[Abstract] The probability density distribution is determined for a generalized algorithm to detect signals at the limits of the observation interval. At an infinitely small observation time interval, the process at the detector integrator output is defined by MacDonald's function. At large values, it is defined by an asymptotically normal distribution law. For narrowband noise the probability density distribution of background noise for the generalized algorithm with a small observation time is defined by an exponential law, and for large values by an asymptotically normal law. The processes at the input and output of the detector integrator are examined. Filtering is described. Figures 2; references 14: 10 Russian, 4 Western.

Computing Ground Surface Relief Features With Signal Processing in Airborne Navigation Systems For Determination of Speed and Range

947K0092A Moscow in Russian No 2, Feb 94 (manuscript submitted 26 April 93) pp 3-18

[Article by M. S. Yarlykov and V. I. Shvetsov, under the rubric "Radio Engineering Systems"; UDC 621.396.96:629.7.05]

[Abstract] Employing Markov theory of optimal estimation, the authors solve problems in the synthesis of algorithms of optimal signal processing in air navigation systems for determining range and speed. A number of air navigation problems require determination of range rate and slant distance to a particular point on the earth's surface. Availability of pulse-Doppler radar equipment allows these speed and range values to be determined, and the use of inertial navigation systems and linear acceleration sensors provides increased precision in these determinations owing to coordination of data from the separate systems. Radio signal processing is useful in accomplishing this type of coordination. Common algorithms of contemporary signal processing in pulse-Doppler and inertial navigation systems applicable to determination of range rate and slant distance rely on the assumption that variations in the height of ground features may be ignored. In a number of cases, e.g., extremely rugged terrain, this assumption is unwarranted. Development of optimal and quasi-optimal algorithms for processing data from pulse-Doppler and inertial guidance systems is possible based on Markov theory of nonlinear estimation of random processes. A two-dimensional, coherent-separable, Gaussian random field, which is described by a stochastic differential equation in partial derivatives of a hyperbolic type, serves as a mathematical model of ground surface features. A circuit diagram of an airborne system for determining range and speed, based on the mathematical findings is presented. The approach used to compute relief features may also be applied to related problems in developing radar systems for surface scanning and correlation-optimalizing navigation systems. Figures 8; References: 7 Russian.

AVIATION AND SPACE TECHNOLOGY

Underground Future of Rocket Technologies

947F0122A Moscow KONVERSIYA V MASHINOSTROYENII in Russian No 2, Apr-Jun 93 pp 12-16

[Article by A.A. Kolesnikov, A.A. Lapin, and S.N. Mishin; UDC 622.24: 658.149.3]

[Abstract] Rational reorienting of the unique experience in gyroscopic precision instrument design and manufacture from the aerospace rocket system of the past toward oil and gas drilling of the future is considered, this being a technology conversion problem with more than one possible solution. Inasmuch as the basic requirements are maximum cost effectiveness and shortest time of adapting the military gyroscope technology to a civilian economy, of interest is automation of directional drilling currently the object of research and development activity at the Scientific Research Institute of Applied Mechanics imeni Academician V.I. Kuznetsov. An automatic control system for this special application is being developed there, an optimum design still being searched for. The directional drilling control system consists of two separate structures:

- 1. one underground in the well with controls, a set of transducers, and a navigation module (logging apparatus, magnetometer, gyroscopic inclinometer, electronic apparatus), primary and secondary electric power supplies, and mechanical protection;
- one on the ground above with a control module, a set of transducers, a monitor set, and operator panel electronics.

The gyroscopic measuring system also consists of two separate structures with two-channel communication: 1. the one underground in the well with an inclinometer and a secondary electric power supply, 2. one on the ground above with another primary electric power supply and operator panel electronics. Another variant of a gyroscopic system, for stope measurements, includes also a computer and a wireless single transceiver channel. Underground equipment is provided with mechanical protection and temperature regulation. Application problems in addition to theoretical engineering problems are involved in:

- 1. development of sensors suitable for underground operating conditions;
- design of effective directional (angles) control set;
- synthesis of an optimal drilling control algorithm;
- development and design of a two-way communication channel connecting underground and on-ground apparatus or a one-way channel with a feedback loops;
- ensuring reliable failure-free operation of all system components underground under extremely severe service conditions;
- ensuring compatibility of the automatic control system with the essential technological processes and equipment;
- optimization of measuring and logging instruments to ensure fast response and reset of primary-data transducers.

The key concepts so far proposed for goals are:

- 1. a drill coolant fluid with characteristics matching the real geophysical environment;
- statically and dynamically stable "stope - drill rod" system;
- closed automatic control system with feedthrough and feedback of inclinometer readings (azimuth, zenith angle, drilling angle) and odometer readings to the stope control unit, to the pulley set, to the rotor drive, and to the pump station;
- visual display of essential information about status of drilling operations, with indication of imminent anomalous deviations from nominal values and with recommendations as to countermeasures;
- changeover from automatic to manual drilling and indicator navigation mode;
- forced cooling of drill compartment;
- vibration proofing the instruments by means of the robust panels and, considering the slow response required of the control system, vibration proofing the sensors by means of "deep" viscous damping;
- submersible bare-mounted electronics;
- hydroacoustic magnetostrictive or piezoelectric two-way communication channel, possibly with intermediate repeaters;
- display of navigation data (azimuth, zenith angle, drill direction and trajectory), geophysical data (stope temperature, gamma or gamma-gamma radiation level, neutron absorption level), and physical conditions (pressures including drill fluid pressure and pump outlet pressure, forces and moments acting on drill bit, state of electric power supply, functioning of electronic equipment).

Figures 3.

Use of Extruded Al-Li Alloy 1450 Semifinished Products in Modern Transport Aircraft

947F0144 Moscow TSVETNYYE METALLY in Russian No 4, 1994 pp 44-48

[Article by A. M. Drits, A. G. Vovnyanko, T. V. Krymova, All-Union Scientific Research Institute of Aviation Materials; UDC 669.715.017]

[Abstract] Highly durable Al-Li alloys are being developed for aircraft. They must conform to the specifications for durability, fracture ductility, growth rate of fractures, and corrosion resistance. This paper summarizes the results of studies of the effect of chemical composition, aging, deformation between hardening and aging, texture and granular structure on the properties of alloy 1450. Alloy 1450 has the following composition (in%): Cu 2.7-3.3; Li 1.8-2.3; Zr 0.08-0.14; Ce 0.005-0.15; Ti 0.02-0.05; Fe 0.15; SiO 0.1; Mg 0.2; Na 0.002. The copper content does not have a significant effect. The effect of lithium depends on the aging temperature and cut direction. Addition of magnesium to 1450 may be expedient, but requires correction of the thermal processing mode to obtain the appropriate specifications. Deformation after hardening enhances conditions which may lead to the formation of microfractures. Hot and cold plastic deformation was examined. Alloy

1450 outperformed D16 and V95, but showed lower relative elongation and fracture ductility. Alloy 1450 is used in various components of AN-70T aircraft. Figures 5; tables 2.

OPTICS AND HIGH-ENERGY TECHNOLOGY

Extrapolation of the Location of an Object in Two-Way Scanning Systems

947f0135 Moscow PRIBOROSTROYENIYE in Russian No 7-8, 1993 (manuscript received 22 Mar 93) pp 50-56

[Article by Yu. N. Litvinova, St. Petersburg State Academy of Aerospace Instrument Building; UDC 519.233.2]

[Abstract] In a two-way scanning system, object parameters are measured in alternating time intervals. Formulas are obtained to extrapolate the value of linearly changing coordinates in two-way scanning. The time interval depends on whether the number of samples taken and the number of extrapolation periods are odd or even. Expressions are obtained for the dispersion of the extrapolation error. When all measurements are equally accurate, the extrapolation process is reduced to a weighted sum of the measured coordinate values. The weight coefficients depend on the number of measurements, the number of samples, the number of extrapolation periods, and whether they are odd or even. The expressions that are obtained are optimized for maximum probability for uniform movement in a straight line. References 2 (Russian).

NUCLEAR AND NON-NUCLEAR ENERGY

Optimum Geometry of Experiment for NGR Phase Analysis of Material

947F0116A Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 60 No 4, 1994 (manuscript received 28 May 1992) pp 25-29

[Article by S.V. Sinitsyn, Minsk Scientific Research Institute of Radioactive Materials, BYLEARUS; UDC 543.53]

[Abstract] Since nuclear gamma resonance is being utilized for quantitative phase analysis of iron-bearing and tin-bearing materials, a method is proposed which will minimize changes in the background radiation spectrum caused by oscillations of the gamma source. The method takes into account that resonance γ-radiation (r) consists of NR-quanta emitted without recoil and R-quanta emitted with recoil, while nonresonance γ-radiation (nr) includes several spectral components m covering the 100-200 keV energy range and several spectral components j of characteristic x-radiation (xr) emitted by the host material of the gamma source and by the implanted in it Moessbauer isotope. The theory of the method is based on the complex angular ($d\Omega$) and energy (dE) distributions $dI(r)_{NR,R}/dSd\Omega dE$, $dI(nr)_m/dSd\Omega dE$, $dI(j)_{xr}/dSd\Omega dE$ of the amounts of respective radiation quanta I(NR,R,m,j) leaving the interior of the source through an area element dS of its surface per unit time. On the basis of a design and performance analysis, a NGR experiment is arranged with the collimator placed between the gamma source and the detector on their common axis that a cylindrical "penumbra" zone and a conical "shadow" zone around it exist behind the gamma source. Relations applicable to such a scheme are established for calculating the critical distances and sizes which will ensure the optimum measurement geometry. As a test case is considered NGR absorption spectrometry for determining the concentration of a certain phase in the material of a plane-parallel specimen which has a single-line NGR-spectrum. It is shown that both the minimum distance $h(0)_s$ from the gamma source to the collimator aperture and the amplitude of oscillations $\Delta h(0)_s$ of the gamma source relative to the collimator aperture should be minimized, inasmuch as increasing them will increase the statistical error of phase concentration readings even though it will decrease the form change of the spectral line per measurement. Figures 3; references 5.

Inhibiting Acid Corrosion of Metals and Alloys of Thermal Power Plant Special Water Treatment Equipment in Highly Aggressive Media

947F0129 Kiev ENERGETIKA I ELEKTRIFIKATSIYA in Russian No 2, 1994 pp 39-42

[Article by N. N. Berezkin, V. A. Korovkin, Yu. Ya. Van-Chin-Syan, Lvov State Trust on Organization and Effective Use of Regional Power Plant and Grids, Energoprogressa Training-Scientific-Production Association, Rovno Atomic Power Plant, Lvov Polytechnical Institute; UDC 620.197.3]

[Abstract] Typically, deposits on the inside of heat exchanger pipes are removed chemically with aqueous solutions of mineral and organic acids or composites based on these acids. The austenite stainless steel and occasionally ferrous metal content of pipes must be considered when developing a deposit remover to avoid acid corrosion of the metal. Solutions were made from the production waste water from chemical and pharmaceutical facilities. The use of reclaimed acid discharges eliminates the use of expensive nitric acid. It also significantly reduces the volume of alkali which must be used to neutralize the acid solution. When the solution included enhancers, corrosion was virtually completely suppressed. Testing was done to optimize the concentrations of inhibitors in the acid solutions. One problem which was encountered was foam production when the acid solution reacted to dissolved carbonate deposits. The foam hinders access of the wetting solution to the deposits. A foam quencher was added, low-molecular fatty acids. The acid corrosion inhibitors effectively suppress the destructive effect of highly aggressive solutions of nitric acid. Figure 1; tables 4; reference 1 (Russian).

Artificial Formation of Petroleum and Natural Gas Deposits

947F0113A Moscow VESTNIK ROSSIYSKOY AKADEMII NAUK in Russian Vol 64 No 2, Feb 94 pp 115-122

[Article by I.I. Nesterov, corresponding member of Russian Academy of Sciences, director of Western Siberian Scientific Research Institute of Geological Exploration and Petroleum]

[Abstract] Simple estimates based on evidence about existing petroleum and natural gas (methane) deposits and about their extraction demonstrate that, contrary to prevailing opinion, new deposits can form without migration of hydrocarbons. Although no underground and especially vertical jet flow of hydrocarbons occurs in nature, the possibility should not be completely ruled out. Research done on artificial formation of such deposits involved a search of organic substances throughout nature, including both its fauna and flora, certain conversions of any such substance then being necessary for eventual petroleum and methane production. Among the various indicators only the concentration of paramagnetic centers has yielded the most important characteristic of these substances: energy potential of their molecules. Albedo measurement by neutron logging has also yielded important additional information. In this way, with the aid of statistical analysis, has been obtained some evidence about catageneses in the various mesozoic strata of Western Siberia. Other main factors determining the producibility of petroleum and natural gas are the ambient temperature- pressure conditions necessary for the desired conversion of organic substances into petroleum and natural gas. Again, contrary to prevailing opinion, pressure rather than temperature have been found to play the leading role. Internal stresses acting on bed masses and continuously changing as a consequence of tectonic movements need also to be considered, inasmuch as these changes induce electromagnetic fields. The faster these movements and attendant changes occur, the stronger will be the fields induced by them and the more probable will be generation of electron fluxes in the form of "underground thunderstorms." It is thus doubtful whether seismic waves are always reflected and refracted by the acoustic mechanism only. The chemical process of producing gaseous and liquid hydrocarbons from a solid organic substance containing paramagnetic centers at the ends of aliphatic substituents in the naphthalene rings is shown schematically on the example of conversion from $11C_{11}H_{24} + 16C_{16}H_{34}$ to CH_4 in seven successive stages. The material to be buried in a bed mass for formation of an artificial petroleum deposit must satisfy five requirements:

- be compatible with the bed mass so that the latter will be receptive to simulation of the rock sinking process with attendant pressure rise and subsequent pressure return to its lower original level;
- ensure that a collector will form during or remain after the change of stresses in the bed mass and thus provide space for nascent hydrocarbons;
- contain an amount of organic substance sufficient for 30 vol.% of it filling all pores and cracks in that collector during conversion from solid to liquid and gas;
- have an initial concentration of paramagnetic centers in its organic component not lower than (300-500) x 10^{20} spins/kg;
- be buried under a not lower than 10-15 MPa starting pressure at a not lower than 50°C.

The first two requirements can be met by pumping through wells sand, proppant, or other substance which induces an electromagnetic field when it moves and ensuring penetration of this substance through a larger than 200 m radius around each well. The three last requirements can be met by burying argillaceous- bituminous rocks containing more than 5 wt.% organic material. The results of laboratory and industrial field experiments by the aforementioned methods indicate that in injection of hydrophobic proppant into a 2869-2904 m deep suite under a pressure of 41-54 MPa contributed to formation of deposits containing 15 wt.% organic material with about $600x10^{20}$ spins/kg of paramagnetic centers. Within three weeks the daily petroleum shortfall had decreased from 60 m^3 to within 26-10 m^3. Figures 6.

Nontraditional Power in the State Scientific and Technical Program of Russia, 'Ecologically Clean Power'

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[Article by E. E. Shpilrayn, N. L. Koshkin, O. S. Popel, Ministry of Science of Russia, IVT [expansion not given], Russian Academy of Sciences; UDC 620.9]

[Annotation] This article presents projects included in the section titled "Nontraditional Power" in the State Scientific and Technical Program of Russia, "Ecologically Clean Power." The State Scientific and Technical Program of Russia, "Ecologically Clean Power" was developed by the Ministry of Science of Russia with the participation of other departments, scientific research institutes, and organizations in Russia, and has been implemented since 1990. The program contains a separate section on "Nontraditional Power."

Based on competitive selection, and with a consideration of the recommendations of the Scientific Council of the Ministry of Science of Russia and the Russian Academy of Sciences, the nontraditional power section includes about 20 projects with specific customers contributing their own funds toward the creation of technologies, equipment and installations which convert solar, wind, geothermal, and biomass energy into electric and thermal energy, primarily for the needs of independent consumers in remote or poorly accessible regions. Projects have also been developed to create systems and complexes to use low potential heat with heat pumps, the waste heat of energy enterprises, the energy of small water currents, and other sources. The Ministry of Science of the Russian Federation is providing financial support for scientific research and development of projects included in the state program, and is making practical implementation a priority.

Attention has been focused on the development and creation of real working demonstration and experimental projects for comprehensive in-situ testing to reveal all the advantages of using renewable sources of energy, that is, the economic, ecological, and social advantages, etc. Also important are those developments which have been completed by mass production organizations that produce installations and instruments which use nontraditional renewable sources of energy.

Some projects provide for the creation of combined (hybrid) systems which simultaneously use two or more renewable sources of energy, for example, solar and wind energy in conjunction with batteries and traditional back-up energy sources, which should increase the reliability of the provision of electricity and heat to consumers.

Development of power installations using geothermal energy are oriented toward the creation of factory-ready modular constructions, which can increase the reliability of the equipment and speed up and reduce the cost of construction when these assemblies are installed at their places of use, as a rule, in remote or poorly accessible regions, for example, Kamchatka and the Far East.

The majority of technologies and equipment used to convert non-traditional renewable forms of energy have no harmful effect on the environment and may be considered ecologically clean. The production of energy from these sources makes it possible to replace significant amounts of organic fuel in short supply, reduce the transportation of fuel to remote regions, and eliminate the formation and negative effects of combustion products, including ashes, nitrogen oxides, and sulfur, on the environment.

As a rule, the potentials of various regions of Russia for using renewable sources of energy are virtually unlimited; however, widespread introduction is presently hindered by technical, technological, and economic factors. These factors are closely interrelated and have a mutual, and sometimes contradictory, effect on one another. Changing one of the factors usually leads to a serious change of the situation as a whole.

Among the technological factors which may be considered is the absence of a wide range of real finished developments and factory-ready equipment mass produced using special equipment and progressive special materials and components. The experience of previous years has shown that reliable non-traditional power equipment may be created only in the presence of a market, large-scale mass production, and with the organization of maintenance services.

The interest of developers and manufacturers, at least in the early stages of production, must be supported by financing research and development work and investing in the construction of large facilities, such as geothermal electric power plants, solar electric power plants, systems of wind powered electric power plants, etc.

At present, a large number of economic and social factors will aid in sparking the interest of individual citizens, and agricultural, consumer, and health sectors of the economy of Russia in acquiring and using assemblies and equipment which use renewable sources of energy. These factors include, first, the sharp increase in the cost of fuel; second, an increase in legislative requirements on environmental protection, which is ever more actively supported by the local population; third, the real possibility of using the resources of the defense industry to produce nontraditional energy equipment at a high technical level in conversion programs; and fourth, scheduled changes in the tax and credit policy for users, producers, and developers of new equipment, including nontraditional power equipment.

Brief description of projects and progress as of the beginning of 1993

Use of wind energy

The section titled "Wind power" in the State Scientific and Technical Program of Russia includes three main projects to develop wind power plants with a power of up to 8, 100, and 250 kW. Domestic and global experience in developing wind power has shown that wind power plants at this power level can find widespread practical use to provide energy to independent consumers and to form part of windfarms in a common electric power network. Moreover, the Ministry of Science of the Russian Federation is financially supporting a number of developments in the creation of small portable, dismountable wind electric power plants with a power output of up to 1 kW to provide electricity and water to independent agricultural consumers. Domestic and foreign experience shows that attention should be focused on the reliability and lifetime of the equipment. Very important in this regard is factory and in-situ testing, and the introduction of procedures for certification. Below are main characteristics of wind power projects developed in the framework of the program. Concise information is given on the current state of these developments.

Autonomous wind electric installations with a power of up to 8 kW (Developers, Veten Scientific Production Complex, Mil Moscow Helicopter Factory; customer: The Energobalans-SOVENA Association).

In this project two models of wind power generators are being developed. The generators made by Veten Scientific Production Complex are improved versions of the mass produced AVEU-6 generator produced by Vetroen Scientific Production Association. They are quieter than the AVEU-6. The installations are equipped with a storm shield, reliable current controllers, and improved electrotechnical equipment.

Main specifications of the equipment Rated power at wind speeds of 7.2 and 9.3 m/s, kW ....4.0 and 8.0 Diameter of wind wheel (standardized), m.8 Number of blades.2 Range of wind speeds, m/s ...4-25 Weight of equipment (without foundation), kg 1000 Tower—Tubular, three section Generator Asynchronous

The main purpose of this generator is to provide power to independent users in the consumer sector, in particular, to provide electricity and heat to individual homes with an area of up to 80 m^2 These generators may yield an annual fuel savings, depending on use conditions, of 2-5 tons of fuel.

A full set of design and technological documentation has been developed for this generator. In 1993 experimental models will be manufactured by a forge and pressing factory in Odessa and the Priborostroitel production association in Rybinsk.

The Mil helicopter factory in Moscow has developed wind power generators with a power output of 3 kW using modern aviation designs, in particular, high-revolution (8000-10000 rpm) electric generators. The design documentation has been transferred to the Motorostroitel factory in Perm for production.

Main specifications of the equipment Diameter of wind wheel (standardized), m.6 Number of blades.-2 Weight of equipment (without foundation), kg -360 Height of tower (steel pipe), M 15-Guaranteed lifetime, hr 30,000-Total lifetime, hr 150,000

The use of aviation technologies has made it possible to significantly reduce the weight of the equipment. The generator can be comprised (at the request of the customer) of several units to convert electric energy: a unit to output "dirty" electric energy (for lighting, and for heating water) $U = 220$ V, $f = 50$ +/-5 Hz; a unit for "clean" electric energy with stabilized voltage and frequency, $U = 220$ V, $f = 50$ +/- 5 Hz; and a unit to power radio equipment with a DC output voltage $U = 12$ V. According to developers' estimates, this wind power generator will be several times more expensive than traditional domestic wind power generators, but will be competitive on the world market.

Wind power generator with an output of up to 100 kW (developer, the Ufim Aviation Institute; customer, the Bashkortostan technology park)

Main specifications of the generator Rated power at a wind speed of 10.0 m/s, kW.100 Diameter of wind wheel, m.24-Number of blades (of composite material) -3 Weight of equipment (without foundation), t 20-Height of tower, m 25 Generator Contactless, synchronous.

This generator was developed as a basic module for building wind power plants and forms using several wind power generators operating independently or in parallel with an electric power network. The installation can be used with a diesel generator. It is intended to provide power to settlements with a population from 50 to 500, and the calculated annual fuel savings is 60-100 tons of ideal fuel.

The primary model of the VEU-100 is planned to be manufactured and delivered for testing in Bashkiria at the end of 1993, and in 1994 an experimental set of generators is proposed.

Wind power generator with an output of up to 250 kW (developer and manufacturer, Polyemtransmash Production Association; customer, the Energobalans-SOVENA Association).

Main specifications Rated power, kW at a wind speed of 13.7 m/s.250 at a wind speed of 16.0 m/s.400 Diameter of wind wheel, m 24 Number of blades (fiberglass) 3 Weight of equipment (without foundation), t 25-Height of tower, m 24 Generator Asynchronous with a phase rotor.

This wind generator is intended for use in parallel with a power network. It saves up to 200 tons of ideal fuel per year. It can be used with diesel generators.

At the end of 1992 a primary sample of the generator was manufactured and was installed in a special area near Novorossiya for testing. The production of an experimental set is slated for 1993.

Small wind power generators for agriculture (developer, All-Union Scientific Research Institute for Agricultural Electrification, Russian Academy of Agricultural Sciences; customer, the Ministry of Agriculture of Russia)

Three types of small wind electric power generators are being developed:

The VES-P portable wind electric power generator (Fig. 1). The main uses are charging batteries, supplying power for television and radio, and providing power for lighting to independent consumers.

Figure 1. VES-P portable wind electric power generator.

Main specifications Rated power, W.50 Range of working wind speeds, m/s 3-10-Rated voltage, V 12-Capacity of battery, Ahr 50 Weight (without battery), kg 30 Lifetime, years 10

The VVU-1.5 portable wind electric water pump. The main areas of application are pumping water in individual subsidiary farms and in pastures, and providing lighting and power for consumer appliances.

Main specifications Range of working wind speeds, m/s 3-10 Rated voltage, V 12 Average daily volume of water pumped from a depth of 10 m, m^3/day 1.5 Weight (without battery), kg 40 Lifetime, years 10.

The VVU-6.0 dismountable wind electric water pumping installation. The main areas of application are pumping water on peasant farms and small farms, and supplying independent electric power.

Main specifications Rated power, kW.1 Range of working wind speeds, m/s.3-10 Rated voltage, V.220 Average daily volume of water pumped from a depth of 10 m, m^3/day.6.0 Weight (without battery), kg.....150 Lifetime, years.....10

In 1992, experimental models were manufactured and testing began. Mass production is slated to begin at the Azimut Scientific Production Association (St. Petersburg) in 1993-1994. The installations are competitive with gasoline powered electric generators and it is assumed that they will, to a certain extent, help to solve the problem of electrifying independent agricultural consumers, and improve the living conditions of shepherds, reindeer herders, geologists, and other sectors of the population.

In 1992 TOO MOLINOS [expansion not given], which was formed at the Moscow Aviation Institute, completed development of the M-250 wind electric power generator and began production at the Lavochkin Scientific Production Association factory (in Khimki).

Specifications of the M-250 Rated power (at 8 m/s), W.250 Voltage, V.12 Diameter of rotor, m.1.7 Blade material.Fiberglass or aluminum alloy Number of blades-3 Profile-.NASA 4412 (SV-1) Wind speed at beginning of operation, m/s-3 Generator-3-phase collectorless with permanent magnets Capacity of battery, Ahr350-Average annual productivity, kWhr 600.

Use of solar energy

The section of the program on the development and creation of equipment to convert solar energy into electricity and heat in the "Nontraditional power" section includes five projects. Two of them develop and mass produce modern solar installations which convert solar energy into low-potential heat to produce hot water, heat, and other heat processes. This field is the most technically and economically established for widespread practical use in various regions of the country. Three other projects involve the support of the development of photoelectric energy conversion. These developments are primarily oriented toward the future, although at present, as world experience shows, photoelectric equipment is in practical use, primarily to provide power to small autonomous objects.

Development of designs and organization of mass production of a new generation of solar collectors (developer, Krzhizhanovskiy Energy Institute; customer, MITRA NPP [expansion not given]).

The main goal of this project is to develop new solar collectors and to create the production potential to manufacture solar collectors with a high level of thermotechnical and operational specifications for use in autonomous installations and systems to provide heat and hot water for communal living quarters and production facilities. The solar collectors which are to be developed should have the following basic specifications:

Optical efficiency.no less than 0.8 Total coefficient of heat loss, W/(m^2K) .no greater than 6 for collectors with selective coatings on the absorbing panel, W/(m^2K-no greater than 4 For polymer collectors, W/m^2K-no greater than 8 Lifetime, years.up to 15 For polymer collectors, years.8-10 Specific mass, kg/m^2-no greater than 30

To meet these requirements, which have been formulated on the basis of world experience in this field, the project is developing and testing special materials for solar collectors: hardened glass with an anti-glare coating, thermal insulation materials, materials for heat absorbing panels, and the appropriate selective coatings. Effective designs have been developed for solar collectors based on corrosion-resistant steel and polymer panels. Attention has been focused on the creation of the necessary experimental base to provide thermotechnical and service-life testing of solar collectors and for their certification. To this end, the Institute of High Temperatures of the Russian Academy of Sciences and the Krzhizhanovskiy Energy Institute have created appropriate testing facilities based on solar radiation simulators. A state standard for the testing of solar collectors has been developed and work is continuing to establish a procedure for certifying solar collectors produced domestically.

The Krasnogorsk factory for aviation technology equipment of the Ministry of Defense of the Russian Federation is industrially producing solar collectors made of stamped and welded absorbing panels made of corrosion-resistant steel with hardened glass, foam polyurethane heat insulation boards and a special aluminum casing. This collector design most fully embodies recent domestic developments in the field of solar collectors. The collector has the following specifications:

Area, m^2.1.63 Area of heat receiving panel, m^2.1.50 Weight (without heat carrier), kg47 Specific mass, kg/$m^2$27.6 Optical efficiency0.79 Total coefficient of thermal losses, W/(m^2K): with a selective coating ("black nickel")3.2 black paint-5.2 Lifetime years12.5

This solar collector matches the best foreign models in its thermotechnical and operating specifications.

Development and organization of production of solar-fuel autonomous heat and hot water units for settlements (developer, Central Scientific Research and Design Institute for Typical and Experimental Design of Engineering Equipment of the Ministry of Architecture of Russia; customer, the Kub firm)

The autonomous solar-fuel complexes include three units: a natural water purifier, a boiler, and auxiliary unit. The units are factory ready and come with a set of solar collectors. They can be delivered to the installation site in three trailers and are joined together into a single complex which purifies 100 to 400 m^3 of natural water per day and produces thermal energy to provide heat and hot water for settlements with a thermal load from 1 to 3 MW.

In the process of implementing the project a proposal was made to develop modular boilers using various types of organic fuel to be used in conjunction with the solar water heaters based on solar collectors, which were developed in the previously described project. The use of solar energy saves up to 20% organic fuel, improves the ecological situation and improves on technological processes.

In 1992 technical and economic justification for the creation and construction of solar-fuel complexes was completed. In 1993 there are plans to complete design work and begin creating experimental-demonstration models of the equipment.

Portable photoelectric stations and dismountable solar water pumps (developer, All-Union Scientific Research Institute of Agricultural Electrification, Russian Academy of Agricultural Sciences; customer, the Ministry of Agriculture of Russia).

The goal of this project is to develop an ecologically clean technology for producing large (100 mm in diameter) single crystal silicon solar elements and a standard size series of portable and mobile modular photoelectric stations for individual consumers and businesses.

In 1992 All-Union Scientific Research Institute for Agricultural Electrification began experimental production of photoelements with an annual output of about 20 kW. They have created demonstration models of photoelectric stations and dismountable solar water pumps with the following specifications (see table).

Name	Production level	Application
FES-5	5 Whr/day	Provide electricity to the pulse generators of electric fences, and low-power radio equipment
FES-25 (Fig. 2)	25 Whr/day	Provide electricity to low-power radio equipment and mini-lamps, charge batteries
FES-150	up to 150 Whr/day	Local lighting, distill potable water, power radio equipment, power low-power production equipment
SVU-1.5	up to 1.5 m^3/day	Individual orchard-garden plots, pump water from a depth of up to 20 m
SVU-6.0	up to 6.0 m^3/day	Pasture livestock, pump water from a depth of up to 40 m

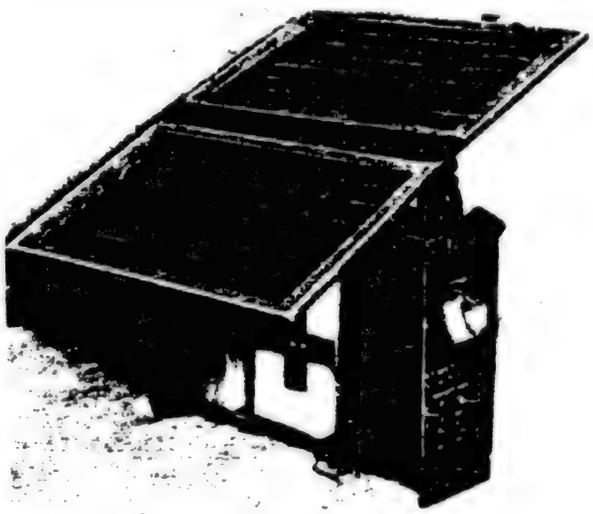

Figure 2. FES-25 Photoelectric station.

The mass production of the installations is being carried out at the Sapfir Scientific Production Association in Moscow and the Integral factory in Minsk.

Development and construction of an experimental-demonstration 1 MW solar electric station (developer, Institute of the Rostov Thermoelectric Project, The Krzyhizhanovskiy Energy Institute; customer: The Stavropolenergo POEE [expansion not given]).

In this project, a multi-profile experimental solar electric station is being developed which includes a unit for photoelectric conversion (concentration of solar radiation) and thermodynamic conversion of solar energy into electricity, as well as systems to use the waste heat and water heat with solar water heaters. The location for the proposed construction of the experimental electric station is the Kislovodsk region. The main specifications of the proposed solar electric station, according to the results of technical and economic justification carried out in 1992 are as follows:

Peak electric power, kW-1500 Average electric power, kW-820 Peak heat power, kW-10,600 Average thermal power, kW.5790 Annual output of electricity, MWhr.1650 Annual heat output, MWhr.11,000 Area occupied by station, hectares-15 Number of solar modules, sets: Photoelectric station (with concentrators).240 Paraboloids with Stirling generators-54 Solar water heaters with parabolic-cylindrical concentrators-60 Average efficiency of solar electric station, %.10 Volume of fuel replaced, tons of ideal fuel/yr-2000.

From a purely economic point of view this experimental unit is not profitable; however, its creation is important from the point of view of the development of research and development and the accumulation of experience in using this type of equipment with an eye toward the future.

Development and organization of production of photoelectric modules of amorphous silicon with an output of 1 MW per year (developer, Saturn Scientific Production Complex; customer Kvantempagro, Moscow City Division).

Russia is lagging far behind many countries in the production and use of photoconverters made of amorphous silicon. The world commercial use of these elements has increased tremendously in recent years. Photoelements of amorphous silicon are an order of magnitude cheaper than crystalline silicon photoconverters, and require much less silicon. Consequently, the goal of this project is to develop the technology and industrial production of these photoconverters using domestic technological equipment.

It is assumed that in the first stage the photoelements that are produced will be primarily used as power sources for watches, calculators, medical equipment, radios, and other appliances. Later it will be possible to create larger power modules.

In 1992 research was done to justify this technology for producing photoelements. Experimental samples with a glass substrate attained an efficiency of 6%. The basic

technological equipment was manufactured for the experimental portion of the production of photoelements for the entire technological cycle, with an annual production of up to 200 m^2 (about 10 kW) of elements. A technical assignment was developed to design a production line with an output of 1 MW per year; this level of output is planned for 1995.

Use of geothermal energy

This section of the state program includes the development of three projects.

Modular geothermal stations using the steam hydrothermae of the Sakhalin region and Kamchatka (Developer Kaluzhskiy Turbine factory, Moscow Energy Institute; customer, Kamchatskenergo POEE [expansion not given])

This project is aimed at using the steam hydrothermal sources of Sakhalin and Kamchatka, and proposes the development, creation, and organization of mass production of domestic modular geothermal heat and electricity stations with an output of up to 20 MW. One- and two-loop schemes for power stations are being developed; the working fluid in both cases is steam.

Based on studies done in 1992 by the Kaluzhskiy turbine factory, two geothermal heat stations with a thermal output of 23.2 GW/hr were manufactured with titanium heat exchangers and a one-loop geothermal power generator with an output of 500 kW, the OMEGA-500. This generator is intended for experimental use on Kunashir Island. Design work has been completed for a series of geothermal power generators with an output of 23 MW for the Mutnovsk geothermal thermal electric power plant and the San Jacinto geothermal thermal electric power plant in Nicaragua. In all cases, in accordance with ecological requirements the geothermal fluid is pumped back into the stratum.

The geothermal power and heat units which have be developed have the following thermal carrier parameters, which are characteristic for geothermal formations in the Far East:

Temperature, °C .105-170 Pressure, MPa .up to 0.8 Moisture content .0.2-0.65 Gas content, % .0.2-0.5 Mineralization, g/kg-0.5-2.0.

Main specifications of the OMEGA-500 power generator

Electric power, kW.500-600 Rated parameters of steam at turbine input: Pressure, Pa-$7x10^5$ Temperature, °C-165 Consumption, t/hr-18 Parameters of electric power produced: Type ..3-phase Frequency, Hz ..50 Voltage, V ..400 Number of containers .1 Weight of container, t.20 Size of container, m-8.3x3.0x3.5.

Main specifications of GTS-700 modular geothermal heating unit (Fig. 3) with a titanium heat exchanger

Thermal power, MW .20 Rated parameters of geothermal heat carrier: Pressure, Pa.....$2.0x10^5$ Temperature, °C-110 Consumption, t/hr-50 Parameters of heated water: Temperature, °C.90 Pressure, Pa.$3x10^5$ Consumption, t/hr.690 Weight of container, t-32 Size, m-10.5x3.0x3.5.

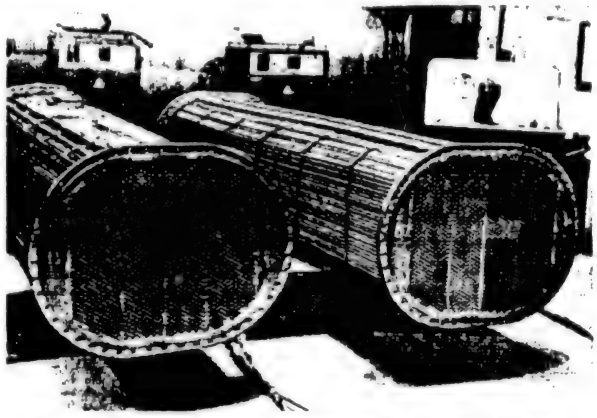

Figure 3. Titanium heat exchanger of the GTS-700 modular geothermal heating station

Successful implementation of the project makes it possible to speed up the use of geothermal formations with minimum expenditures and time to put the equipment into use. The modern approach to the creation of factory-ready reliable power modules, which makes them competitive on the international market.

In the conditions of the Far East the geothermal generators which have been developed are more effective economically and ecologically than diesel electric power stations, thermal electric central lines, and boilers which use expensive fuel delivered to the site.

Ecologically clean geothermal electric power station based on an underground circulation system in Stavropol Kray (developer, Kirovskiy Zavod association, Krzhizhanovskiy Energy Institute; customer, Stavropolenergo POEE [expansion not given])

Geothermal formations in the south of Russia, in contrast to formations in the Far East, are characterized by high mineralization. Ecological requirements mandated the development of reliable two-loop schemes, equipment to convert energy and pump the heat carrier back into the source, and the creation of an underground circulation system for effective practical use of these resources.

The project is directed toward the development and creation of an experimental geothermal station with a power output of 2 MW at the Kayasulinsk geothermal site in Stavropol Kray.

The thermal carrier is a high-temperature (165°C) geothermal brine with a mineralization of up to 100 g/l extracted from a depth of 4200-4400 m.

Main specifications of the experimental geothermal electric power station Rated power of module, MW-2 Number of wells, each.2 Debit of geothermal brine, t/hr.210 working fluid: loop 1.Pentane loop 2.Butane Annual production of electricity, million kWhr-15 Electricity consumption of system,%-30.

In 1992 development was completed on the project documentation for the basic equipment of the geothermal

electric power station. A 300 kW heat loop was manufactured and tested at the Kayasulinsk testing ground. The heat exchanger-evaporator was brine/freon modeling a turbine throttle device, air condenser, and freon supply pump. The testing confirmed the capability of the thermal scheme of the geothermal thermal electric power station. There are plans to complete manufacture and installation of the basic power equipment of the station in 1993.

Experimental-industrial factory for comprehensive use of the geothermal waters of Dagestan with utilization of the heat and extraction of valuable components (developer, Geotherm Scientific Research and Design Institute; customer, GAZPROM RAO [expansion not given]).

The northern Caucasus is characterized by significant supplies of geothermal heat in geothermal highly mineralized (>200 g/l) brine with a temperature of about 100°C. Extraction of this heat can be expediently done at the same time as one extracts valuable chemical compounds from the brines, such as calcium, magnesium, and lithium salts, compounds containing iodine, bromine, boron, and other elements.

The project is aimed at developing methods and equipment for comprehensive use of geothermal brines. An experimental-industrial factory has been developed with two geothermal wells of the Tarumovsk site with a water temperature of up to 170°C. The first line of the factory is designed to process 1.3 million m^3 brine per year with the production of a commercial volume of magnesium, lithium, and bromine compounds.

In 1992, a set of in-situ studies of the heat exchanging equipment, the processes of salt incrustation and corrosion were carried out to validate the thermal scheme and the composition of thermotechnical equipment for the planned factory. In the experimental device studies were done to work out various technologies for obtaining rare earth and chemical products (lithium concentrate, calcined magnesium and bromine). Technical and economic justification was developed and initial data were issued for the design of the experimental industrial factory. The primary consumers for the chemical products were determined.

Samples of future chemical products were tested, and conclusions were reached about their quality and possible industrial use of potential consumers.

In 1993 the design of the factory will be completed and construction will begin. The factory should go into operation in 1995.

Use of biomass energy

World experience shows that one of the most effective ways of using biomass energy is anaerobic processing with the production of biogas and fertilizers. This simultaneously solves the important ecological problem of disinfecting waste products. Also important are the development and use of thermochemical technologies for processing solid biomass into fuel in a gaseous form. The State Scientific and Technical Program of Russia, "Ecologically Clean Power" includes three such projects.

Bioenergy system to process chicken droppings of the Tsentralnaya poultry factory of Vladimir Oblast (developer, Institute All-Union Scientific Research Institute for Complex Problems of Machine Building for Animal Husbandry and Feed Production; customer, Tsentralnaya poultry factory)

The goal of the project is fundamental improvement of the ecological situation near the poultry factory and a 10-12% reduction in the use of organic fuel by using processed biomass. The technology for processing poultry droppings and dropping run-off which has been developed makes it possible to simultaneously produce fertilizers and decrease the nonrenewable use of industrial water by 10% by creating a circulating water system using the reservoirs of biological purification of liquid run-off with the simultaneous production of fish which are bred in these reservoirs.

The bioenergy unit has the following specifications:

Volume of methane tank, m^3-500 Number of methane tanks.3 Volume of waste processed, m^3/day.400 Moisture content of processed waste,% .92 Temperature of fermentation process, °C.40 Annual production of biogas, million m^3.3.5 Annual production of concentrated fertilizer, 1000 t.40 Volume of purified industrial water, 1000 m^3/yr.100 Area of fish breeding reservoir, hectares-about 40.

In 1992 development of the design documentation for the basic technological equipment for the system was completed, and centrifuges were manufactured and tested to separate the waste fraction (40 m^3/hr). In 1993 construction of the first line of the bioenergy system was begun, with planned activation in 1994.

Individual biogas units for peasant farms (developer, Biomassa Scientific Research Center, Ekon joint stock company; customer, Ekon joint stock company).

The goal of this project is the development and mass production of small biogas units for farms with 2 to 6 head of cattle, 20-60 pigs, or 200-600 chickens. The unit has the following specifications:

Volume of bioreactor, m^3-1.5 Maximum load of organic waste (85% moisture content), kg/day-300 Maximum output of biogas, m^3/day.12 Output of liquid ecologically clean fertilizers, kg/day-100-200 Temperature of fermentation, °C-52-53 Output of electric heater of thermostat system, kW-1.

The unit meets the needs of a family of 4-5 for biogas for household purposes (primarily for preparing food), and makes it possible to process all available organic waste and obtain high-quality fertilizer.

In 1992 mass production of individual biogas units, the IBGU-1 (Fig. 4), began at the factory of the Stroytekhnika joint stock company in Tula, the Orlovskiy Repair-mechanical factory in Orel, and the Machine building factory in Yurga (Kemerovo oblast). A total of 25 units were manufactured and delivered to customers.

Figure 4. IBGU-1 individual biogas unit.

In 1993 work continues to improve the design of the unit and implement new modifications.

Thermochemical gas generators to process solid biomass into fuel in gaseous form (developer, Energotekhnologiya TOO [expansion not given]; customer, Committee on Power of the Northwest Region).

The goal of this project is the development and implementation of ecologically clean waste-free technology to obtain electricity and heat from renewable local forms of fuel and waste by thermochemical gasification and subsequent use of the resultant gas in industrial furnaces, steam furnaces and water heating boilers and in diesel equipment.

Main specifications of the developed gas generators Type of fuel..Industrial shavings, waste from sawmills, bark, peat, agricultural waste, and wood. Moisture content of raw material, %No higher than 60 Efficiency, %.No less than 70 Thermal power, kW-from 50 to 5000.

In 1992 designs were developed for a gas generator to obtain fuel gas from fine disperse raw material (the Tsiklon system) with a thermal output of 2.5 MW, as well as burners, furnaces, and a thermal generator to burn low-calorie generator gas, a diesel thermal electric plant based on a 0.6 MW gas generator, residential gas generators with a thermal power output of 50 kW to heat greenhouses and for other purposes. A demonstration model, the TES-600/200 was manufactured and tested with an electric output of 200 kW. It uses generator gas obtained from waste wood. In 1993 there are plans to mass produce these units. Scientific and technical problems linked with the conversion of diesel generators to run on generator gas have been solved. The main direction of work is a gas diesel mode with 10% start-up heat with diesel fuel. In 1993 work should be completed on gas generators to obtain fuel gas from fine disperse raw material, which will expand the area of application of gas generators which process vegetable matter.

Development and creation of micro-hydroelectric stations

This section of the program concerns the development of various types of micro-hydroelectric stations with an electricity output from hundreds of watts to several dozen kilowatts. This equipment would make it possible to effectively use the energy of small rivers, mountain streams, and irrigation channels for autonomous supply of power to industrial and residential consumers. Two projects are being developed in 1993.

Free-flow damless pipeless micro-hydroelectric station and hydro-pumping station with an output of up to 0.4 kW (developers, All-Union Scientific Research Institute for Agricultural Electrification, Russian Academy of Agricultural Sciences and the Energiya Association; customer, the Ministry of Agriculture of Russia).

In this project, in 1993, demonstration models of micro-hydroelectric power stations were developed, manufactured, and tested. The units have an output of up to 400 W and use a stream of water flowing at 0.7-3.0 m/s. The distinguishing features are the use of a free-flow turbine, modular construction, low weight (25 kg), and the ability to combine the units with a dismountable hydro-pumping unit to lift water to a height of 20 m, with an output of up to 500 l/hr. The units can be used in any streams of water in spring, summer, or fall when there is no ice on the surface. In 1994 there are plans to mass produce these micro-hydroelectric stations.

In parallel with this development, portable hydro-pumping stations have been created (Fig. 5): turbolifts with an output of 100 to 1000 l/hr for a water flow rate of 0.6-3.0 m/s and a water lifting height of up to 25 m.

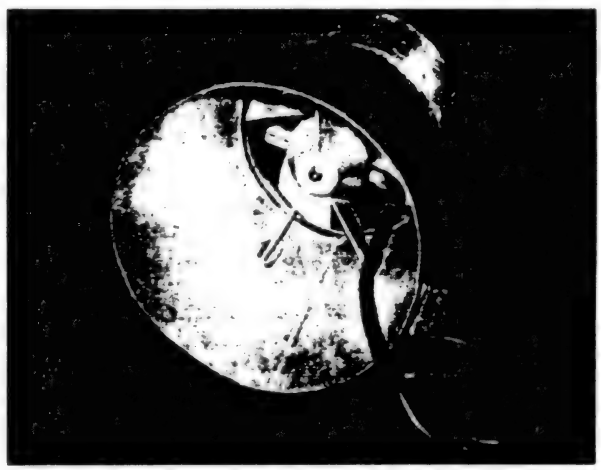

Figure 5. Portable turbolift-water pumping installation.

Micro-hydroelectric station with an output of 40-100 kW (developer, Generator Design Bureau; customer, Naprogid joint stock company at the Polzunov Scientific Production Association of the Polzunov Central Scientific Research and Design Boiler and Turbine Institute).

The units which have been developed are intended for use as autonomous sources of electricity and for operation in a network. In 1992 the MRO 60-406-50 with an output of 40 kW was manufactured and tested. Its main specifications are listed below:

Range of reactions, m.40-50 Output, kW.40-50 Efficiency, %....80 Generator type ....Synchronous Voltage produced, V.230/400 Frequency of alternating current, Hz.50 Diameter of derivation conduit, mm..300-400 Weight, kg..960

The first industrial models of the micro-hydroelectric unit will be delivered in 1993 to the Altai Kray. Lower reaction units (to 5-10 m) are being developed which will make it possible to expand the regions of practical use.

The State Scientific and Technical Program of Russia, "Ecologically Clean Power," includes in the "Nontraditional Power" section several projects aimed at the development of several energy-saving technological processes and equipment.

Experimental-production energy-biological complex using the waste heat of industrial enterprises to enhance the production of food products based on ecologically clean technologies (developer, Institute of the Atomic Energy Project of the Ministry of Atomic Energy of Russia; customer, the Kursk atomic energy plant).

The goal of this project is to develop optimal technologies to use the heat of low-temperature (up to 25°C) waste water at power plants and industrial sites to enhance the production of food products while observing rigorous ecological requirements.

The Kursk atomic energy plant was selected as the experimental base for testing the developed technologies. An energy-biological complex was created in the power unit with an output of 1 GW. The complex has the following parameters:

Heating of 1000 hectares of open ground with additional cooling of industrial water, which enables two harvests (about 20,000 t) per year of commercial vegetable products; heating of a greenhouse with an area of 100 hectares (200,000 t of vegetable products); fish breeding factory with an output of 6000 tons of commercial fish per year.

It is assumed that the technology and equipment tested at the Kursk atomic power plant will be copied at other power plants and industries with significant amounts of unused waste heat.

In 1992, theoretical and experimental studies were completed to validate the energy-biological complex at the Kursk atomic power plant. Design documentation was developed for the main technological units of the complex. A unit was created and tested which processes organic waste with an automatic system to regulate and control the process. In 1993 construction of a complex began with gradual introduction of units into use. All construction should be completed in 1995.

Heat pump systems for heating anc cooling agricultural buildings using low-potential thermal energy of the surface layer of ground (developer, Insolar joint stock company; customer, the Ekomash firm.

This project proposes the development and production of ATNU-10 automated heat pumps and the creation of demonstration systems of heating and cooling for residences. The pumps would use the heat of low-potential ground heat as the main source of heat. These systems are in widespread commercial use in the US and Europe. In Russia, development of such systems has only recently reached the experimental testing stage. The economic effectiveness of these systems is assured by their ability to obtain 2-4 kW of useful heat power per 1 kW of electric power expended on the compressor of the unit over the entire territory of Russia. This yields a 50-75% reduction in the use of energy to heat buildings. The ATNU-10 has the following main specifications:

Heat production, kW 10.3
Rated electric output, kW.....3.5
Temperature of heat carrier at output of system to collect low-potential ground heat, °C.....3-8
Temperature of heat carrier at input of heating system, °C 45
Voltage, V
220/380
Coolant R-22
Capacity of hot water tank, l.....200
Temperature of hot water, °C.....50
Output of hot water supply system, l/day 1100
Weight of equipment, kg.....136
Dimensions, mm 510x940x1520

The design also includes a built-in 250 l capacity refrigerator.

In addition to developing heat pump equipment, the project includes the development of effective ground heat exchangers, the study of the reliability of these systems, and their effect on the natural thermal mode of the ground. The first demonstration-experimental building equipped with an experimental heating and cooling unit with a vertical system to collect the low-potential ground heat will be put into use in 1993 at the Stroitelstvo exhibition complex in Moscow (Fig. 6). Also in 1993 Ekomash will begin mass production of the ATNU-10.

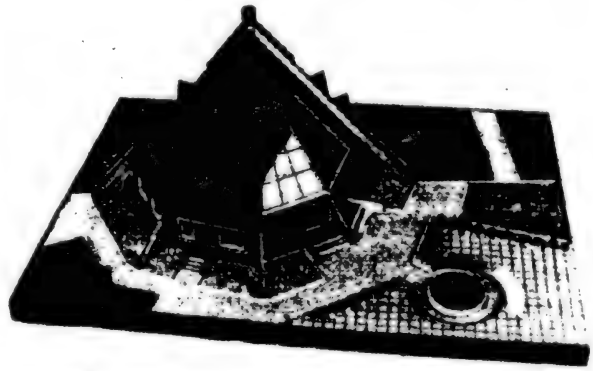

Figure 6. Demonstration-experimental building equipped with an experimental heating and cooling system with a vertical system to collect low-potential ground heat.

Demonstration system to supply power to autonomous rural consumers in Altai kra[5] (developer, Scientific Research Institute of Mountain Land Use; customer, the administration of Altai Kray).

This project proposes the creation of an experimental-production complex at the Belokurikhin scientific production station. The complex would be equipped with various demonstration units created in the framework of the State Scientific and Technical program of Russia "Ecologically Clean Power" in the "Non-traditional Power" section. The complex will solve the following problems:

- determining the most effective modes of power supply to rural consumers using renewable sources of energy, oriented toward the production of various agricultural products;
- testing of efficient modes of use of the power equipment which has been developed in the natural and climatic conditions of Altai Kray;
- organization of training and retraining of specialists in the design and use of equipment which uses ecologically clean renewable sources of energy.

The complex would include biogas units, thermochemical gas generators, micro-hydroelectric power stations, heat pump assemblies,and other systems of great interest to potential consumers in the Altai region.

This project is intended to aid in creating an infrastructure in Altai Kray for the undertaking of comprehensive work to implement new ecologically clean renewable sources of energy in the krai economy, and to stimulate the creation of a market for nontraditional sources of energy with a low power output.

The creation of the experimental-production complex is slated for 1993-1994.

To sum up, it should be noted that these projects do not encompass all developments in the area of nontraditional renewable sources of energy undertaken by many organizations in Russia outside of the framework of the State Scientific and Technical Program of Russia, "Ecologically Clean Power," including those projects assigned by other ministries, departments and private companies.

It should also be stressed that projects included in the State Scientific and Technical Program of Russia," Ecologically Clean Power" were selected carefully on a competitive basis and the conclusions of leading Russian specialists in the area of renewable sources of energy, and as a rule, reflect the existing level of science and technology in the country.

Under the current social and economic conditions it is extremely complicated to insure a successful advancement of the projects. some projects were formed as joint developments of organizations in different republics which were part of the USSR. Recently, this collaboration has become more complex, and many non-Russian organizations have been compelled to cease work in the framework of the Russian state program. This has led to a need to correct projects and the complement of participants. The extremely limited possibilities of state financial support of projects has also held back the implementation of projects.

Compared with foreign countries the volume of targeted state financial support of developments in the are of nontraditional renewable sources of energy in our country is tens, even hundreds of times lower.

Nonetheless, the planned goals have been reached in many projects: in the last 2-3 years developments in most projects have reached the stage of creation of experimental models of units or even mass production.

This article has not represented information on the cost of these installations. This is becomes of the continuous change in prices due to inflation and the formation of a free market. Also, as a rule, the cost of domestic installations of this class, as well as those produced abroad, are somewhat lower when determined in hard currency. This gives domestic producers the basis for successful competition in the world market. The problem is only one of attaining or surpassing the specifications of world standards. For some equipment, there are grounds to believe that this technical level has been achieved (geothermal modular units, solar collectors, heat pumps, biogas units, etc.). Thus, the problem of certification of this equipment in accordance with international standards becomes exceptionally important.

With the sharp increase in the price of fuel and energy, and the tightening of ecological requirements, there are broad opportunities for mass use of renewable sources of energy in our country, especially in remote regions which do not have sources of centralized power and heat delivery. In this situation it is necessary to activate marketing and advertisement of developers. Simultaneously it is also necessary to have an active government policy stimulating the producers and consumers of installations which use ecologically clean renewable sources of energy.

Current State and Prospects for Development of Geothermal Energy in Russia

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[Article by O. A. Povarov, G. V. Tomarov, N. L. Koshkin, Scientific Training Center of Geothermal Energy, Moscow Energy Institute, Ministry of Science of the Russian Federation; UDC 620.9]

[Text] This article shows the prospects for the development of geothermal energy in Russia. The main problems in creating geothermal power plants are examined. Features and specifications of modular geothermal electricity and heat plants currently in operation and under development in Russia are presented.

[Text] The development of power engineering is being hindered by negative ecological consequences from traditional thermal, atomic, and hydroelectric plants, greater shortages, and the inevitable increase in prices of fossil fuels. Greater attention is being focused on nontraditional sources of energy. The most developed form of renewable energy today is the use of the Earth's geothermal heat. In the last decade there has been an annual global increase of 10-20% in the rated power of geothermal electric power plants, and the total power produced by geothermal thermal electric power plants today exceeds 8000 MW.

Interest in the development of geothermal energy has increased for the following reasons:

- the relative ecological purity of using geothermal heat;
- the competitiveness of geothermal electric and heat plants with traditional heat and electric power plants, particularly in terms of the production cost of electricity and heat;
- the ability to use geothermal sources for combined production of electricity and heat;
- the high economic effectiveness of using geothermal sources in remote and sparsely populated regions.

Supplies of geothermal water and steam hydrothermae with a temperature of 40-200°C and mineralization of 0.5-35 g/l in Russia is mainly concentrated(up to 70%) in the Far East and Western Siberia.

Water-saturated thermally anomalous ash is located in Stavropol at the Kyasulinskoye and Tsentralnoye deposits, in Dagestan at the Tarumovskiy area, and in Checheno and Kabardino-Balkaria. The mineralization of these brines is 70-250 g/l, and the temperatures of collectors at a depth of 4200-5200 m reaches 160-200°C.

The development of energy is vitally important for the far eastern region of Russia. At present, in addition to power plants which use organic fuel (mainly fuel which is transported there) for heat and electricity, there is a large number of diesel electric power plants and boilers. These are the main source of energy, for example, in the Kuril Islands. This causes irreparable damage to the ecology of the region. Due to the limited period when waters are navigable and the substantial load of marine transport there are disruptions in the delivery of fuel. The energy shortage significantly hinders the development of the economy and society in the Far East.

Covering the ever increasing energy shortage with intrarегional resources of fossil fuel is extremely limited. Hydroelectric power cannot substantially affect a reduction in the energy shortage due to the absence of large rivers suitable for industrial use. Many of the rives are spawning grounds for salmon.

It is hardly possible to solve the energy problem in the Far East today with the construction of thermal and atomic power plants due to the perception of the populace of their great cost and long construction time, the high seismicity of the Kuril-Kamchatka region, and the remoteness and scatter of energy consumers. It is difficult to use wind electric power generators here due to the severe climatic conditions This primarily concerns winter periods when hurricane winds predominate. There are abundant snowfalls at a temperature near zero, which leads to snow and ice coating the blades, and disengagement of connectors.

The significant resources of geothermal heat in Kamchatka, Sakhalin, the Kuril Island chain and the features of this region examined above make the development of electrification and heating based on geothermal sources very promising. Their use would undoubtedly aid in solving energy, heat, and many economic and social problems. For example, the development of the fish processing industry, the creation of heated farms to grow fruits and vegetables, the organization of water therapy centers, swimming pools, and tourist facilities, and the bottling of mineral water. Some geothermal formations have significant supplies of volcanic slag or pumice, which makes it possible to organize the production of building materials, which are in extremely short supply in the region. The high mineralization of the steam hydrothermae makes it possible to use them for medical purposes. Moreover, frequently, the steam hydrothermae contain rare chemical substances in commercial concentrations, including cesium, rubidium and gallium. Chemically pure sulfur can also be obtained.

The production of electricity from geothermal sources began in Russia in 1967 with the start-up of the first line of the 5 MW Pauzhetsk geothermal electric power plant on the Kamchatka peninsula. In 1982 its power output increased to 11 MW. However, after this, work to create the Mutnovskiy geothermal thermal electric power plant has been delayed, even though prospecting of the formation began in 1978.

The severity of the problem of providing power in the Far East, the presence of real customers for geothermal power plants, and the appearance of new commercial structures capable of rapidly combining the efforts of leading domestic and foreign specialists to solve complex problems in the creation of geothermal equipment, on the one hand, and the absence of substantial domestic experience in geothermal power and th need to solve serious scientific and engineering problems, on the other, was the basis for the inclusion of a project to create modular geoheat plants for the steam hydrothermae of Sakhalin and Kamchatka in the 1990 State Scientific and Technical Program of Russia, "Ecologically Clean Power."

Leading specialists of scientific research organizations are participating in the implementation of the project, including the Scientific Training Center of Geothermal Energy, the Moscow Energy Institute (the lead organization in the project), Krzhizhanovskiy Energy Institute, Polzunov Central Scientific Research and Design Boiler-Turbine Institute and others, as well as the Kaluzhskiy Turbine Factory joint stock company, Burgazgeoterm GP [expansion not given], Kamchaskenergo GP and others.

An agreement was reached between the Nicaraguan Institute of Energy on the one hand, and the Scientific Training Center of Geothermal Energy, the Moscow Energy Institute, the Kaluzhskiy Turbine Factory joint stock company, and Burgazgeoterm GP on the other to create modular geothermal power stations with an output of 2.5 and 23 MW. An international project of the Ministry of Science of the Russian Federation, Geotermika, began in 1991 to support this project.

At present, the following results have been attained.

Geothermal electric power plant units with intermediate power output

Traditionally, a geothermal electric power plant includes:

- borehole equipment,
- a system to prepare the fuel,
- a turbine, condensation equipment,
- a water supply system,
- and an electric system.

The least developed equipment in this country is the borehole head equipment and the steam preparation systems.

To increase the efficiency and volume of work in this field, the Scientific Training Center of Geothermal Energy of the Moscow Energy Institute organized a competition to develop proposals for technological schemes and operational modes for a system to prepare steam for a geothermal electric power plant. These proposals were summarized and various developments were examined in the scientific seminar titled "Problems in Geothermal Energy" in June 1992, which has held at the Kaluzhskiy Turbine Factory joint stock company. A total of 26 organizations and enterprises participated.

Figure 1 shows the final model of a schematic for a system to prepare steam for a 23 MW geothermal power unit. The unit is mainly based on a development created by the Scientific Training Center of Geothermal Energy of the Moscow Energy Institute and the Kaluzhskiy Turbine Factory joint stock company. In the selection of concepts and specific steam preparation system equipment, attention was focused on solving ecology problems, operational efficiency, and prevention of erosion, corrosion, and salt incrustation of elements of the loop.

High efficiency and reliability of the turbine equipment is primarily provided by high-quality drying of the geothermal steam, which is removed from the working fluid with an impurities separator. A steam-water mixture with a moisture content of 50-70% passes through a borehole horizontal gravity separator and at the output has a moisture content of 0.05%. The dried steam from 3-5 borehole separators is collected in a stationary gravity separator-steam collector. Steam with a moisture content of no greater than 0.05% is then sent to the turbine.

The gravity separators were developed by specialists at the Kaluzhskiy Turbine Factory joint stock company, the Scientific Training Center of Geothermal Energy of the Moscow Energy Institute, VNIIAM [expansion not given], Krzhizhanovskiy Energy Institute, and Burgazgeoterm GP. The highest efficiency of moisture removal matches other types of devices in weight and size specifications. The basic elements of both models of separators have been standardized. The separators make it possible to eliminate separately implemented impurity removers, steam valves, collection tanks and collectors.

The proposed separation scheme makes it possible to stay within the maximum permissible level of salt content in live steam (1 mg/kg). The presence of a separator stage in the Kaluzhskiy Turbine Factory joint stock company turbine makes it possible, without substantially complicating the scheme, to provide additional scrubbing of the steam in the stationary separator, reducing salt content by more than an order of magnitude.

Steam from the expander is used to power the ejectors. The material from the separator is discarded to the ejectors after it leaves the borehole separators. This increases the economic value of the power unit by almost 10%.

The problems of erosion, corrosion,and salt incrustation are solved by optimal selection of materials, and substantial reduction of the aggressiveness of the steam by drying and scrubbing, as well as by fortifying vulnerable parts of the structural elements using special inhibitors to prevent corrosion during use and when the system is shut down.

An important advantage which increases the ecological cleanliness of the power unit is the use of a burial borehole in the condensate pumping system. The condensate contains harmful substances. A dynamic noise attenuator

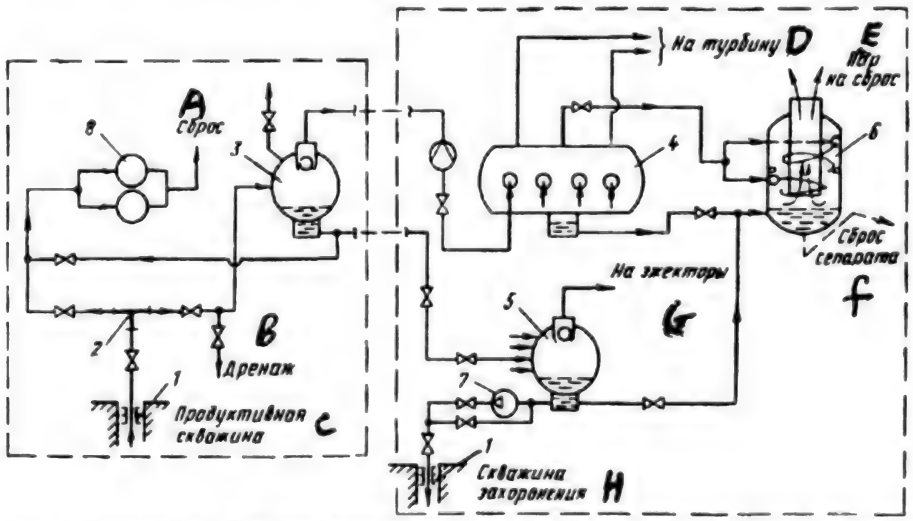

Figure 1. Schematic of the steam preparation system of the geothermal electric power plant.

Key: 1. borehole compensator; 2. distributor; 3. borehole separator; 4. modular separator-steam collector; 5. expander; 6. modular noise attenuator; 7. pump; 8. borehole noise attenuator. a. disposal; b. drainage; c. productive borehole; d. to turbine; e. steam to disposal; f. disposal of separated material; g. to ejector; h. burial borehole.

developed at the Scientific Training Center for Geothermal Energy makes it possible to eliminate noise pollution and scalding of the environmental surroundings. This dynamic noise attenuator design implements a new original principle for noise attenuation which is as follows. The ejected geothermal heat carrier is divided into two streams which are fed tangentially from various levels into the space between the vessels of the device. Active mixing in parallel planes of on-coming eddies leads to dissipation of sound energy and eliminates the propagation of a sound wave along the axis of the device. This insures highly efficient sound attenuation. The vibrational movement of the streams increases the stability of the unit and allows it to separate moisture from the ejected steam. This noise attenuator design eliminates the possibility of transfer of salts to the flow-through passages of the device, which is a serious drawback of traditional direct flow devices and other types of devices.

The design of the 23 MW turbine assembly of the geothermal electric power plant is shown in Fig. 2. The flow-through part of the turbine has seven stages and uses internal-channel peripheral separation and a highly efficient stage-separator (fourth stage). The use of a stage separator reduces the moisture content in the flow beyond the turbine from 15 to 10%. The relative internal efficiency of the flow-trough part of the turbine, which was developed by the Kaluzhskiy Turbine Factory joint stock company, reaches 0.839 for a nominal load. A rotating regulating diaphragm delivers and regulates the use of the working fluid of the turbine.

After it leaves the turbine the steam enters a mixing condenser (p_k = 0.012 MPa. There is an circulating water supply with an air ventilator evaporator.

At present the Kaluzhskiy Turbine Factory joint stock company is completing technical planning and is beginning manufacture of the 23 MW power plant for the San Jacinto geothermal electric power station (Nicaragua), with a total power output of 5X23 MW, and the Mutnovskiy geothermal electric power plant, with a total power output of 4X23 MW. The Kaluzhskiy Turbine Factory joint stock company is also conducting work to design and create three power plant units with a power output of up to 6 MW for the Pauzhetskiy geothermal electric power station. The Kaluzhskiy Turbine Factory joint stock company has developed a design for a 12 MW geothermal power plant. Some specifications of the turbogenerator unit of modular intermediate power output geothermal power plants are given below:

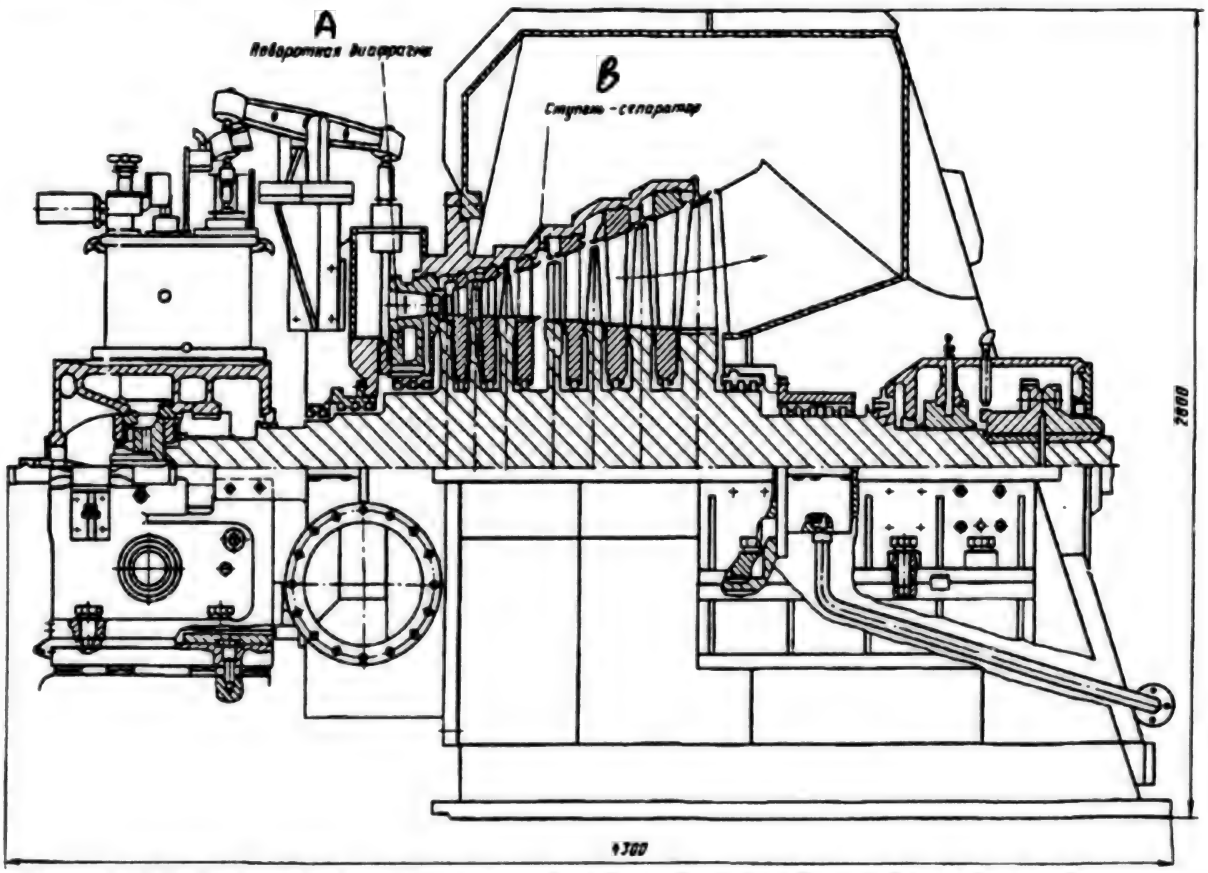

Figure 2. 23 MW turbine for a geothermal power plant by the Kaluzhskiy Turbine Factory joint stock company.
Key: a. rotating diaphragm; b. stage-separator.

Power, kW	6000	12000	23000
Input pressure, MPa	0.2	0.6	0.7
Steam consumption. T/hr	75	90	170
Pressure after turbine, MPa	0.01	0.0085	0.012

Modular Low-Power Geothermal electric power plants

Technical and economic calculations show that in addition to the construction of large geothermal electric power plants like the Mutnovskiy and Pauzhetskiy with 23 and 6 MW units, it would be expedient in sparsely populated regions of the Kuril Islands, Kamchatka, and Sakhalin to create a series of modular geothermal power plants with a relatively low power output (0.5, 1.7, 2.5, 4.0 MW). In the new design, these containerized modular geothermal electric power plants would be installed at an individual borehole and would link consumers or power nodes with power transmission lines.

Modular geothermal power plants have the following advantages:

- minimization of construction, no need to lay extended conduit to link the boreholes with a traditional geothermal power plant,
- preservation of the landscape,
- and reduction of the harmful effects of a geothermal power plant on the environment;
- containerized construction substantially simplifies delivery to the installation site in poorly accessible regions of geothermal formations;
- factory-ready modular construction reduces costs and simplifies installation and start-up, which is especially important for regions with severe climatic conditions;
- the automation system permits a virtually unmanned technology for using modular geothermal power plants;
- substantial reduction of investments;
- highly efficient equipment reduces the time needed for the equipment to pay for itself to 1-2 years;
- the amount of ideal fuel saved by using a modular geothermal power plant may reach 4500-7300 t/yr;
- simplicity and easy accessibility of the basic equipment simplifies and increases the efficiency of servicing;
- modular low-power geothermal electric power plants may be used in worked-out boreholes and those which are not suitable (due to reduced parameters) for further use in large geothermal electric power plants;
- it is also possible, when necessary, to quickly move them from one borehole to another.

The first domestic experimental-production module from the Kaluzhskiy Turbine Factory joint stock company was put into operation in the beginning of 1993 on Kunashir Island in the Kuril chain. Some specifications of the unit, the OMEGA-500, are presented below:

Power, kW	500	1700	2500
			(4000)
Input pressure, MPa	0.7	0.5	0.65
Steam consumption, t/hr	10	38	40
Weight, t	20	40	46.5
Dimensions, m	8.3x3.03x3.49	10.5x3.03x3.49	10.5x4.7x3.6

Figure 3 shows a photograph of the exterior of the OMEGA-500 turbine module. The 500 kW turbogenerator module is a separate container. Figure 4 shows a typical configuration of the equipment of the turbogenerator module with 0.5, 1.7, and 2.5 MW turbines. The module of the system to prepare the working fluid is in a special frame at the borehole and includes a compensator, borehole armature, separation device, noise attenuator, and a system to monitor and measure the parameters of the geothermal heat carrier.

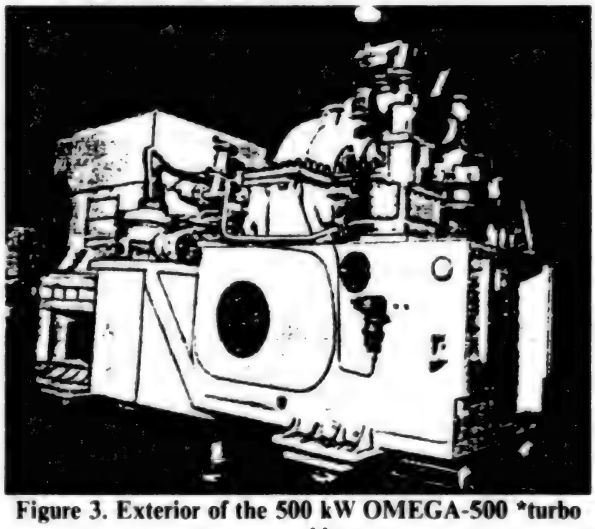

Figure 3. Exterior of the 500 kW OMEGA-500 *turbo assembly.

At present, the Kaluzhskiy Turbine Factory joint stock company is designing and manufacturing modular 1.7 and 2.5 MW geothermal power plants which, like the OMEGA-500, work without a condenser at the exhaust pipe. A technical proposal has been prepared for the next step in improving the low-power power units: modernization of the 2.5 MW geothermal power plant module. When an air condenser is included, this will increase power to 4.0 MW for the same initial parameters of the working fluid.

The prospects of the organization of mass production of modular geothermal power plants and their competitiveness on the world market has been confirmed by the current interest of a number of foreign firms.

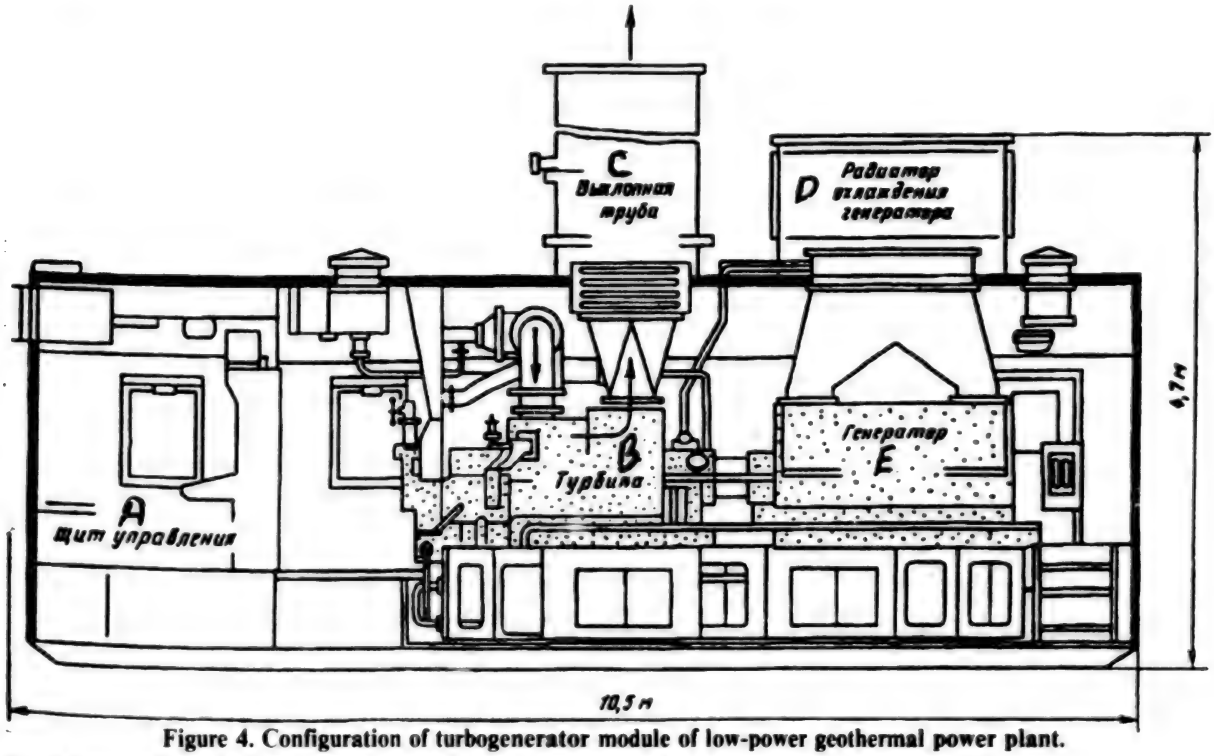

Figure 4. Configuration of turbogenerator module of low-power geothermal power plant.

Key: a. control panel; b. turbine; c. exhaust pipe; d. generator cooling radiator; e. generator.

Two-loop geothermal power plants

Several ecological problems may be solved by implementing a two-loop geothermal electric power station. The concept of a two-loop unit for the steam hydrothermae of the Kuril chain was developed at the Krzhizhanovskiy Energy Institute. This design makes it possible to create operating conditions for the turbine which correspond to the use of traditional thermal electric power plants. The removal of harmful gaseous impurities from the steam generator and pumping of the used geothermal heat carrier into a burial borehole eliminates environmental pollution.

The thermal design of the two-loop geothermal electric power plant includes the following main elements:

- a separation device,
- expander,
- steam generator,
- turbine,
- economizer,
- adsorber,
- ejector,
- condenser,
- and air evaporator.

The first loop uses a water-steam mixture with a pressure of 0.8 MPa. The steam generator has a gravity separation system which should insure a moisture content of the steam passing through the turbine of less than 0.05%. The steam generator proposed for use is the I-600 evaporator type, which is mass produced by the Krasnyy Kotelshchik factory in Taganrog.

In the framework the State Scientific and Technical Program of Russia, "Ecologically Clean Power," and in the draft document titled "Ecologically Clean Geothermal Thermal Electric Power Plant Based on PTsS [expansion not given] in Stavsvropol Kray" a technology for the use of geothermal brines is developed to produce electricity in a two-loop geothermal electric power plant where the working fluid is freon.

Modular geothermal heat plants

The Kaluzhskiy Turbine Factory joint stock company has developed heating modules which use a water geothermal heat carrier, the GeoTS-700V, and had tested a pair of modular geothermal power plants, the GeoTS-700P, with a thermal output of 210 MW. The main specifications are listed in the table.

Specifications of modular geothermal heat plants	GeoTS-700V	GeoTS-700P
Thermal power, kW	20,000	20,000
Heating heat carrier	Water	Steam
Heat carrier pressure, MPa	0.2	0.02
Heat carrier temperature, °C	110	104
Heat carrier consumption, t/hr	500	38
Network water pressure at output, MPa	0.3	0.3
)Network water temperature at output, °C	90	90
Network water consumption, t/hr	690	715
Weight, t	32	36

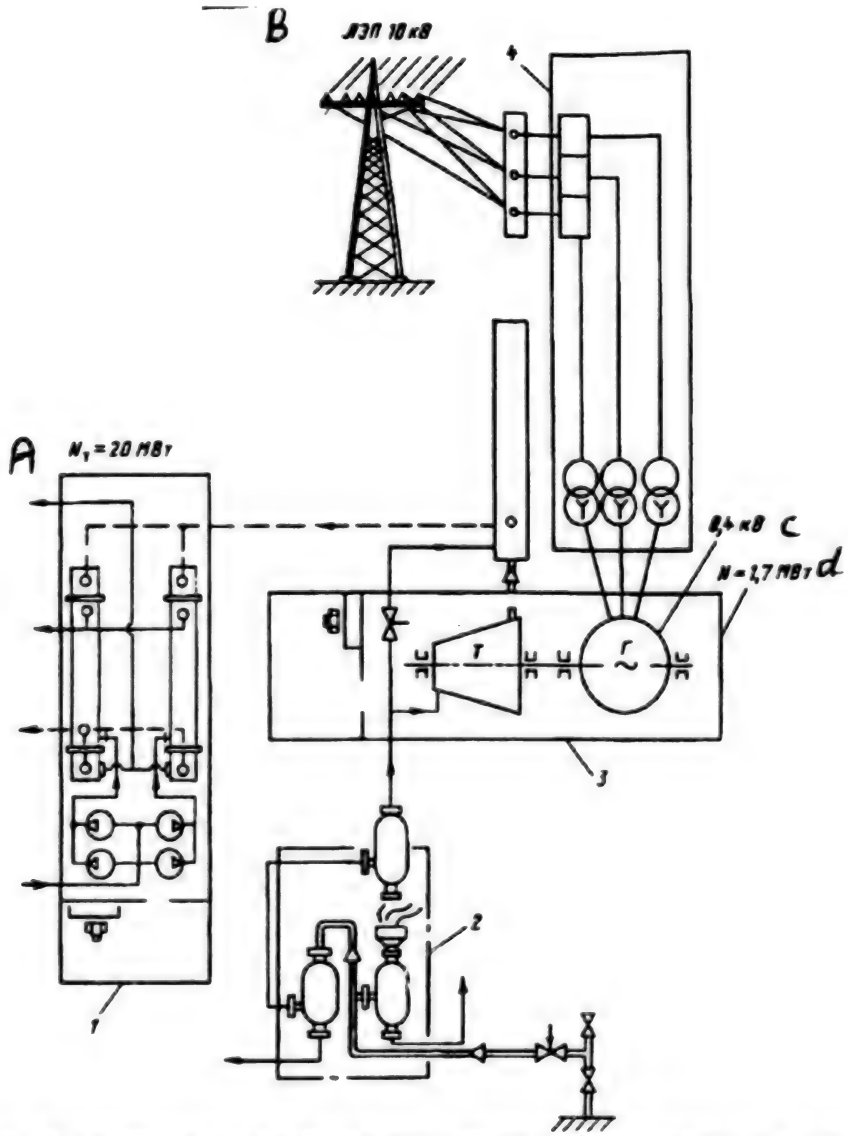

Figure 5. Schematic of the combined production of electric energy and heat at steam hydrothermae using modular installations.
Key: 1. heating module; 2. steam preparation module; 3. turbogenerator module; 4. transformer substation module; a. N_1 = 20 MW; b. electric power line, 10 kW; c. 0.4 kW; d. N = 1.7 MW.

Modular geothermal heat plants, like geothermal electric power plants, are containerized. The Kaluzhskiy Turbine Factory joint stock company has mastered the technology of manufacturing the heat exchangers for the modules from titanium alloys, which significantly increases their lifetime, reliability, and the efficiency of the equipment.

Comprehensive use of modular geothermal power plants and geothermal heat plants will significantly increase the efficiency of use of the thermal potential of geothermal formations. The schematic for this use of geothermal steam is shown in Fig. 5. The use of a 1.7 MW modular geothermal power station with a GeoTS-700P increases the use of the thermal energy of geothermal steam to 75.2% (Ref. 5).

The Kaluzhskiy Turbine Factory joint stock company has manufactured two 20 MW heating modules which use the steam hydrothermae of the Sakhalin region. Work is continuing to develop and create a number of standard size geothermal heat plants with a low output. Since 1993 the Nedra PGO [expansion not given], the Kaluzhskiy Turbine Factory joint stock company, SPGI [expansion not given], and the Moscow Energy Institute have jointly conducted work to develop and create modular heating units based on low-temperature geothermal formations using heat pumps. This work has been done in the framework of the State Scientific and Technical Program of Russia, "Ecologically Clean Power."

Scientific and Technical Problems

Implementation of geothermal energy projects is based on scientific verification of developments, along with comprehensive studies of the gas-hydrodynamics of multicomponent geothermal media, heat and mass transfer, corrosion, erosion, and salt incrustation, creation of experimental facilities, and testing of experimental models of the equipment. Further development of geothermal energy in Russia requires many serious scientific and technical problems to be solved:

- determination of the corrosion and erosion properties of domestic construction materials as they are used in geothermal electric power plants and geothermal heat plants;
- development of proposals for optimal use of these power plants and an increase in the erosion-corrosion resistance of geothermal equipment;
- study of the gas-hydrodynamic behavior of streams of a multi-component geothermal heat carrier in the pipes of geothermal electric power plant and geothermal heat plant equipment;
- determination of the optimal water-chemical mode for geothermal electric power plants and geothermal heat plants, and the development of systems to monitor and correct the quality of the geothermal working fluid;
- determination of the patters of formation and nature of salt incrustation, and development of methods to predict and prevent it;
- improvement of the flow-through parts of the turbines of the geothermal electric power plant; reduction of deposits in the first stages, development of moisture separation within pipes; increasing the efficiency of the stage-separator;
- development of a steam input system with an increased throughput; creation of a highly-effective exhaust pipe and the last turbine stage with a titanium alloy saber blade with a height of about 630 mm;
- development of highly effective methods to protect the elements of geothermal equipment from standing corrosion;
- development of effective condensation equipment, evaporators and circulating water supply systems;
- development and creation of reliable and effective equipment to reduce noise when the geothermal heat carrier is ejected;
- creation of an effective system to pump the used geothermal heat carrier;
- development of modern methods of measuring the chemical thermodynamic, and operational parameters of the working fluid as it is used in geothermal electric power plants and geothermal heat plants.

Today substantial work is being done on many of these problems. Preliminary recommendations have been developed on standards for the water-chemical mode of the geothermal electric power plant. World experience in using geothermal electric power plants and materials used for turbines and auxiliary equipment in geothermal electric power plants has been summarized.[2,3] the Scientific Training Center for Geothermal Energy of the Moscow Energy Institute and the Central Scientific Research Institute for the Technology of Machine Building have developed special experimental chambers at the steam hydrothermae of the Okeanskiy formation (on Iturup Island) and have studied the corrosion resistance of several domestic metals, reaching conclusions about their applicability in geothermal electric power plants.[3] The features of the use of the geothermal media and its effect on the reliability and lifetime of equipment have been established for use in a geothermal electric power plant.[4] Investigations of the inhibiting effects of amines in the geothermal medium are ongoing.

The Kaluzhskiy Turbine Factory joint stock company has tested models of an air condenser. There are plans to test separation, evaporation, and noise attenuating devices. An experimental base has been designed and created to test full-scale models of geothermal equipment for the steam hydrothermae of the Mutnovskiy formation. A special set of experimental modules has been created by the Scientific Training Center of Geothermal Energy of the Moscow Energy Institute to study the process of corrosion, erosion, and salt incrustation, and to diagnose, monitor, and predict the erosion-corrosion state of the metal of geothermal electric power plant equipment.

Thus, successful implementation of these projects by the end of 1995, with certain financial support from the state budget distributed by the Ministry of Science of Russia, will begin the widespread introduction and use of effective ecologically clean modular geothermal electric power plants and geothermal heat plants to supply power to the Far East. Organization of mass production of these plants at the Kaluzhskiy Turbine Factory joint stock company will also begin, which will also enable active emergence onto the foreign market with competitive products.

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Results of Scientific Research and Design Work To Create the Two-Loop Stavropol Geothermal Thermal Electric Power Plant

947F0124C Moscow TEPLOENERGETIKA in Russian No 2, 1994 pp 23-27

[Article by V. A. Vasilyev, V. V. Ilyenko, Krzhizhanovskiy Energy Institute; UDC 621.482]

[Annotation] This paper presents the results of theoretical and experimental studies which enabled the design of non-standard equipment, a system to extract and pump geothermal brine, and a system to remove salt incrustation for an experimental geothermal electric power plant in Stavropol Kray. An evaluation of the competitiveness of industrial geothermal thermal electric power plants with fuel stations is presented. [Text] In the framework of the State Scientific and Technical Program, "Ecologically Clean Power," an experimental two-loop 3 MW geothermal electric power plant will be built at the Kayasulinskiy geothermal site in Stavropol Kray in 1995. This plant will use the heat of geothermal brines. Reference 1 presented the main designs and basic design stages for newly manufactured equipment and the plant itself. This paper presents the results of theoretical and experimental scientific research work which shows the possibility of designing the basic systems and elements of nonstandard equipment of the plant. The following systems are examined:

- extraction of hot geothermal brine and pumping of the used cooled brine into a stratum (an underground circulation system);
- conversion of the heat of the geothermal brine into electricity by evaporation in a working fluid (khladon-142v) heat exchanger, delivery of the resultant steam to a turbine and condensation of the steam in an air condenser;
- combatting contamination of the geothermal brine loop, including scrubbing the brine for mechanical impurities and removal of salt incrustation from the heat exchanger-evaporator.

The remaining systems (delivery of electricity to a network, automation, industrial water supply, etc.) will be implemented with mass produced equipment. An estimate of the competitiveness of the geothermal thermal electric power plant is presented with a consideration of the increase in prices for fuel for energy.

Use of an underground circulation system

An underground circulation system extracts deep heat. The system consists of intake and discharge boreholes, a portion of a productive geothermal stratum, conduit for hot and used brine, and a discharge pumping unit. At the Kayasulinskiy geothermal site the borehole is 4200 m deep, and the thickness of the productive stratum is 100-120 m. The stratum is composed of dolomites and has fracture porosity. The stratal pressure is 51 MPa, the stratal temperature 170°C, and the total mineralization of the stratal brine is 100 g/l. A total of 2.5 m^3 of gases are dissolved in 1 m^3 of brine. Below we present the ion composition of the dissolved substances and the percentage of dissolved gases:

Ions	g/l	mole/l
K^+	0.40	0.01
Na	26.65	1.16
Ca^{2+}	8.62	0.21
Mg^{2+}	0.85	0.035
Li^+	0.058	0.007
Cl^-	62.39	1.75
SO_4^{2-}	0.11	0.001
HCO_3^-	0.68	0.01
NH_4^+	0.05	0.003
B^{3+}	0.10	0.009
Ba^{2+}	0.333	0.002
J^-	0.01	0.00008
$Fe^{2-(3-)}$	0.05	0.001
H_4SiO_4	0.17	0.0016
Rb	0.001	0.0001
Cs	0.001	0.000007
Sr	0.60	0.007
pH	5.7	6.7

Gases	% by volume
Methane CH_4	20.99
Ethane C_2H_4	1.23
Propane CH_8	0.30
Butane C_4H_{10}	i 0.05 n 0.07
Pentane C_5H_{12}	i 0.02 n 0.02
Hexane C_6H_{14}	i 0.01 n 0.00
Heptane C_7H_{16}	0.00
Nitrogen and rare ions	6.81
Carbon dioxide	69.75
Hydrogen H_2	0.62
Helium He	0.13

The main problem in creating an underground circulation system is obtaining the maximum output of geothermal brine in the service life of the plant (30 years) with minimum use of electricity to pump the used brine. The output Q of an ideal doublet of one intake and one discharge borehole is defined from the heat balance:

$$\rho_b c_b Q\tau = \pi/3\ (c_b m + c_r\ (1 - m))(_b m + {}_r(1 - m))ha^2,$$

where ρ_b, c_b, and ρ_r, c_r are the density and heat capacity of the brine and dolomite; τ is the use time; h is the thickness of the stratum; a is the distance between boreholes; m is the porosity of the stratum. The pressure of the discharge pump is determined from the equation

$$\Delta p_p = (_b{}^c - {}_b{}^h)gH + 2Q^2(H + a) + (Q)/(kh)\ln a/r_w,$$

where $\rho_b{}^h$ and $\rho_b{}^c$ are the density of the hot and cold brine; H is the depth of the borehole, ξ is the friction in the operating columns and the conduits; μ is the viscosity of the brine, k is the permeability of the stratum, and r_w is the radius of the borehole.

During hydrodynamic studies of boreholes at the Kayasulinskiy site, indicator diagrams, pressure recovery curves, hydromonitoring, determination of the intake and intake capacity, pumping and tracking of the indicator fluid were used to determine the porosity m and the filtering coefficient $kh/$. Laboratory studies of core material and the brine were used to determine density and thermal capacity values.

When the boreholes were drilled, the productive stratum was traversed with a clayey wetting solution. After the operating columns were removed the tubular space was cemented. The column was then "shot through" with a perforation gun. As a result cracks in the critical zone of the stratum were contaminated, which led to low initial values of the yield of the intake borehole and high pumping pressures (respectively 500 t per day and 20 MPa). To improve these parameters a special method of scrubbing the critical zone was developed which provided effective cleaning of the cracks without noticeable corrosion of the column and pump-compressor pipe. The reagent was a petroleum-acid emulsion with the following composition (in % by volume): gas condensate 40; oxidized petrolatum 5; a saturated aqueous solution of $CaCl_2$ 6; chloride 49.

A total of 60 m^3 of emulsion was pumped into the stratum, and after an hour the borehole became a flowing borehole.

After two petroleum-acid processes, the yield of the intake borehole increased to 6000 t per day (a factor of 12 increase), and the pressure of the discharge pump was reduced to 6 MPa (a factor of 3.3 reduction).

The results made it possible to calculate the basic parameters of the underground circulating system for the experimental geothermal thermal electric power plant:

Distance between boreholes.900 m Diameter of operating columns.219 mm Yield of 2 boreholes.250 t/hr Pressure of discharge pump (2-loop).....6 MPa

These parameters were confirmed in the course of in-situ testing for 700 hours in an experimental loop of the underground circulating system at the Kayasulinskiy site. The results of testing were used to develop an improved design of the intake borehole, which reduces losses to friction and reduces the temperature stresses in the operating column, which reduces the probability of accidents.

Energy conversion system

The significant content of HCO_3^- in the brine, as well as dissolved carbon dioxide gas leads to intense (hundreds of tons per year) sedimentation of calcium carbonate and magnesium carbonate in the expanders when the geothermal brine is used directly. This was established theoretically in a study of the chemical equilibrium and kinetics and was confirmed by direct testing of the expander at the Kayasulinskiy site, which determined the selection of a two-loop model of the power plant consisting of a heat exchanger-evaporator, turbine, condenser, and condensate-delivery pump.

The main goal in creating the power plant is the acquisition of the maximum useful electric power n_e per unit of geothermal brine consumed:

$$n_e = [(h''(t) - h_c)_{oi} - (p - p_c)V_c/_p][c_f b(t_b{}^h - t - 5)]/[h''(t) - h'].$$

Here t, p are the temperature and boiling pressure of the working fluid; p_c is the pressure in the condenser; h'' and h_c are the enthalpy of the steam before and after the turbine; the enthalpy of the liquid at the boiling point is h'.

For each working fluid one can determine the boiling temperature at which n_e is maximal (usually this temperature is close to the half-sum of the temperatures of the hot geothermal brine and its surroundings). One should select working fluids which have a high density of steam at a temperature of about 100°C, so that a normal diameter turbine can have a sufficiently high power. Low boiling point working fluids (khladons), because of the high steam density, provide a somewhat higher power output than water for the same turbine diameter. Working fluids which have a smaller drop in heat in the turbine are preferable, because this makes it possible to reduce the number of stages. Moreover, when one is selecting a working fluid one should also consider such factors as the corrosive activity, their thermal stability, danger of explosion and fire, toxicity, and the effect on the environment in the event of inevitable leaks through condensation.

Thermodynamic analysis of the suitability of eight low boiling point working fluids was conducted (hydrocarbons and halogenic hydrocarbons). A semi-empirical equation for a virtual state was used[2] which made it possible to obtain all thermal and caloric characteristics. Optimization of the Rankine cycle with a consideration of the aforementioned additional factors resulted in the selection of two power plant models: a two-loop model with butane in the second loop and normal pentane in the first loop, and a one-loop design with khladon-142v.

Table 1 presents the basic parameters of the thermal scheme for these two designs.

Comparative specifications of geothermal thermal electric power plant energy units

Parameter	2-loop hydrocarbon unit		1-loop khladon unit
	Loop 1	Loop 2	
Working fluid	**N-pentane**	**Isobutane**	**R142v**
Number of energy units	1	1	1
Parameters of heating medium:			
Consumption, t/hr	210	420	125
Pressure at heater-evaporator input, bars	20	19.8	20
Temperature at heater-evaporator input, °C	160	104	160
Temperature at heater-evaporator output, °C	104	68	68
Parameters of working fluid:			
Consumption, t/hr	83	126	159
Steam pressure before turbines, bars	9.85	12.2	23.5
Steam temperature before turbines, °C	125	76	105
Pressure in condenser, bars	1.12	3.63	3.399
Condensation temperature, °C	39	26	25
Weight of working fluid loaded in unit, kg	1000	1500	3000
Cooling water temperature, °C	10	10	10
Cooling water consumption, m^3/hr	454	2944	1284
Internal efficiency of turbine	0.815	0.83	0.785
Power at generator terminals, kW	1390	1220	1500
Power consumed by system, kW	207	412	394
Specific power, n_e, kWhr/t	5.63	1.92	8.85
Effective efficiency of energy unit	0.124	0.085	0.137

In the two-loop model two modules in loop one lead to one module in loop two; thus the main characteristic of efficiency, n_e is equal to the sum of n_e for loops 1 and 2, that is, $n_e = 7.55$. In this sense, design 2 with khladon-142v is preferable; it is also better in terms of explosion and fire safety. From the point of view of the effect on the atmosphere, khladon-142v is an ozone hazard. Its use is permitted by a protocol of the Montreal Conference.

The next stage of research on the power station was acquisition of the necessary data to construct elements of the equipment: the turbine, the heater-evaporator, and the condenser. In the Northern Caucasus, where construction of this type of geothermal thermal electric power plant is proposed, there is virtually no industrial water to supply the evaporative towers, so a condenser with forced air cooling was selected. Detailed calculations were done for all this equipment using standard methods and additional data available in the literature on the thermodynamic and thermophysical properties of geothermal brine and khladon-142v. In addition, a 200 kW (thermal) model unit was created at the Kayasulinskiy site for experimental verification of the calculations. The thermal scheme was recreated, and it consists of a brine-khladon heat exchanger-evaporator, a throttle (to simulate the turbine), an air condenser, and a condensate-delivery pump. In the course of testing the main specifications of the heat exchanger were verified, in particular the coefficients of heat transfer in evaporation and condensation. In the models of the geothermal brine and khladon loops the rate of corrosion of various construction materials were determined. The testing results for the material of the heater-evaporator pipes, the flow-through part of the discharge pump, and the shut-off armature in the brine loop recommended austenite stainless steels with a chromium content of no less than 16%. In the khladon loop, contact is eliminated with aluminum and titanium alloys.

Optimization calculations on minimization of the size with a sufficient efficiency level were the basis for the selection of the following turbine design: a two-stream turbine with a radial regulating stage and two axial working stages. For effective cooling of the bearings, the interaction of khladon-142v with turbine lubricants was studied. To reduce erosion of the first stage blades, a special scheme was developed to separate khladon steam, providing a droplet entrainment limit of 0.01%.

The results of the studies recommended hermetic constructions for the power generator and condensate-delivery pump to increase the fire safety of the energy units.

Contamination of the heat exchange surfaces

For efficient heat exchange when thermal brine with a complex chemical content is used in the first loop as is the case at the Kayasulinskiy geothermal site, a series of studies was performed to prevent or minimize salt incrustation.

Analysis of the content of dissolved substances has shown that the most intense salt incrustation forms when the brine degases due to disruption of the carbon dioxide equilibrium and calcium and magnesium carbonates precipitate. The maximum thermobaric conditions for the absence of carbonate sediments was found experimentally. At a brine temperature of 165°C (the working temperature of the hot brine) the pressure should be above 1.8 MPa.

The second most prevalent salt-forming factor is the precipitation of barium and strontium sulfates when the brine temperature drops. This process was also carefully studied at the experimental installation at the Kayasulinskiy site.

Below are the rates of accumulation of sediment in relation to temperature:

Brine temperature, °C	107	93	85	78	68	60
Rate, g/(m^{2}hr)	0.139	0.176	0.195	0 .235	0.285	0.36

The chemical composition of the sediments is presented in Table 2. When the temperature of the brine drops in the heater-evaporator, sediments will accumulate. The main problem is the introduction of a limit on the exhaust temperature of the thermal brine, which results in a sufficiently effective energy unit with a relatively small amount of sediments.

Table 2. Chemical composition of sediments, % by mass

Substance	Number of section							
	1	2	3	4	5	6	7	8
SO_3	30	31	31	27	31	32	2 8	30
BaO	27	6.2	14	14	17	22	8.3	21
SrO	14	24	4.7	17	absent	23	absent	10
FeO	22	29	40	31	37	14	40	20
Organic substances	15	9.3	10	11	12	9	24	19

Calculation of the total salt incrustation shows that if the exhaust temperature is limited to 70°C, in a year a 1.5 MW energy module heat exchanger will accumulate 750 kg of sediment. With periodic removal of incrustation every six months, there will be no substantial worsening of the heat exchange, nor the total output of electricity.

A technology for chemical scrubbing of the heater-evaporator was developed and tested in laboratory conditions. Scrubbing is done in two stages: first, the sediment is carbonized by a hot soda solution, then it is dissolved with chloride.

After a forced shut-down and chemical processing of the intake borehole, the geothermal brine contains mechanical particles for one month (mainly clay and cement). To remove them from the geothermal thermal electric power plant tract, a contaminant remover is installed in the borehole. Moreover, to prevent the entry of pipe corrosion products into the discharge borehole, mechanical scrubbing filters will be installed at its mouth.

Evaluation of the competitiveness of the geothermal thermal electric power plant

As reported earlier in Ref. 1, in 1991 design and budget documentation was developed for the creation of the experimental 3 MW Stavropol geothermal thermal electric power plant at the Kayasulinskiy site. This plant will start up in 1995. The next stage is the construction of an industrial scale geothermal thermal electric power plant at the Kayasulinskiy site (30 MW) and at the Tsentralnyy site (50 MW) in Dagestan. The creation of these plants will be possible only if they are competitive with electric power plants which use organic fuel.

Considering the rather rapid increase in prices for gas and oil, as well as the cost of equipment and construction work, it is difficult to predict with any degree of certainty the economic indicators for geothermal or fuel plants in the distant future. Nonetheless, one can track the dynamics of the change in the average charges for electricity in the last two years in the Stavropolenergo energy system compared with calculated values of the cost price of electricity at an industrial geothermal thermal electric power plant (Table 3). Projected indicators of the experimental plant were used with a consideration of the actual coefficients of the increase in cost of equipment, construction work, and the increase in wages for the corresponding period.

Table 3. Change in average charges for electricity

Indicator	Nov 1991	Nov 1992	Mar 1993	Jul 1993
Cost price of electricity at a 30 MW geothermal thermal electric power plant, rubles/kWhr	0.5	2.18	5.2	7.5
Average charge of Stavropolenergo, rubles/kWhr	0.028	1.05	4.0	6.4

From this comparison it is clear that the cost factors converge rapidly. In 1991 the cost price was a factor of 18 higher than the charge; in mid 1993 it was virtually equal. One would expect that even in the next 4-5 years the creation of industrial geothermal thermal electric power plants will become economically expedient.

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Photoenergy-Current State and Prospects for Development

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[Article by N. L. Koshkin, M. I. Fugenfirov, Ministry of Science of Russia; UDC 621.472]

[Annotation] Information is presented on research and development in the direct conversion of solar radiation into electricity. Specific photoelectric devices currently produced in Russia are described. [Text] The photoelectric method of converting solar energy into electricity is currently one of the priorities in the use of nontraditional renewable sources of energy. It has been successfully developed in many countries of the world, including Russia. Signs of progress abroad in this field are: the significant increase in investment in scientific research and experimental design by governmental budget allocations, but predominantly by private companies and firms; the continuous increase in the volume of production of photoconverters and expansion of their areas of application; and significant improvement in technical and economic parameters. Successful development of the photoelectric method of converting solar energy has been aided by a favorable situation in the economy in conjunction with the development of space technology, the increase in demand for low power sources of electricity for autonomous consumers in regions far removed from centralized power grids, as well as an increasing demand for sources of current for consumer electronic devices. The development of this direction of research has also been aided by recent achievements in semiconductor technology, in particular, the results achieved in the US, Japan, and Germany.

However, more widespread introduction of photoelectric systems is hindered by a number of factors: the relatively high cost of solar elements and the electricity obtained from them, and insufficiently high efficiency. These drawbacks can be overcome by searching for and developing new semiconductor structures, creating progressive technologies for the manufacture of photoconverters and special high-performance equipment, and increasing the volume of production. It is important to make an optimal choice of areas of application of photoelectric systems depending on the technical and economic characteristics reached at each stage of development.

In Russia, certain results have been attained.

The specific cost of photoconverters can be reduced by reducing the cost of raw material, reducing labor expenses in the creation of semiconductor structures, reducing the consumption of material per unit area of photoconverter, and increasing the purity of semiconductor material to eliminate harmful impurities in it.

At present, the following technologies for obtaining silicon have been developed:

- An experimental-industrial technology for semicontinuous growing of single silicon crystals up to 100 mm in size using the Czochralski method with replenishment of the crucible, which decreases (by a factor of two) the consumption of quartz crucibles per unit of finished product, and which decreases by 20% the length of the melt, which in industrial production may reduce the cost price of silicon by 25-30%.
- Refining plasma-arc remelting of industrial silicon with and without oxidizing and refining additives, as well as with an additive in the form of a silicon dioxide oxidizer with "single", "double," and "triple" remelting. The loss of initial silicon is no greater than 3-7%, and the purity of the material reaches 99.92-99.99%.
- A technology of obtaining large crystal silicon with a columnar structure, where plasma arc remelting of silicon is combined with directed crystallization. A technology has also been developed to obtain solar grade polycrystalline silicon using the casting method.
- A technology and equipment for growing strips of silicon up to 100 mm wide using the Stepanov method.
- Further reduction of the material used and the cost of photoconverters may be achieved by eliminating the labor intensive operations of cutting slabs of silicon into substrates, which is accompanied by large losses of the initial material. This problem may be solved by using polycrystalline silicon substrates manufactured from profiled crystals grown using the Stepanov method.
- An experimental-industrial technology for growing silicon hollow polyhedrons, which would substantially reduce the consumption of silicon for the manufacture of substrates. Polyhedra can be grown in a Redmet 10 type device at a rate of 15-20 mm/min. Six-sided polyhedra with a 37 mm side can be obtained. Now, there is a technology for growing polyhedra with a side of 60 mm using the Redmet 10m device. These substrates may be used to obtain photoconverters with an efficiency of up to 9.4% with a subsequent increase to 10.5% The Redmet 30 device can be used to develop a technology for obtaining hollow dodecahedra with a 110 mm side; photoconverters using these structures may have an efficiency of up to 12%.

The efficiency of photoconversion can be increased by using semiconductor structures which are more optimal than silicon, from the point of view of photoelectric losses. Such a material is gallium arsenide. The Ioffe Physicotechnical Institute has created photoconverters with a high efficiency using GaAs. The Lunokhod power system is equipped with these converters.

One method of reducing the cost of "solar" electricity is implementing the principle of intermediate concentration of solar radiation and use of photoconverters of single crystal silicon or A_3B_5 compounds at the focus of the concentrators. In this case the area of the solar elements and their contribution to the cost of the power unit will decrease proportional to the degree of concentration. The optimal degree of concentration when silicon photoconverters are used is 20-50 and this is reached with flat Fresnel lenses; for GaAs photoconverters, the number is 100-500, which economically justifies the use of complex cascade structures with a maximum theoretical efficiency of about 40%. The real efficiency of photoconverters which use cascade structures has reached 25%.

To organize research and industrial production of photomodules in Russia, a number of associations, scientific production firms, and small enterprises have been created. In St. Petersburg there are SOLEN, ABSOLYUT, Ekoenergetika, Elionika, and Svetlana-Triak; in Moscow, the Kvant Scientific Production Association; in Krasnodar, Kvark, Musson, and the Saturn Scientific Production Enterprise. Preparations are being made for the production of photoconverters in Rostov, Zelenograd, and Irkutsk.

At the Scientific Research Institute for Agricultural Electrification, experimental production of photoconverters based on single crystal silicon has begun. A number of improvements have been made in the technology for producing them, and this increases the quality of the product and reduces labor. The experimental-industrial technology for manufacturing 100 mm photoconverters with an efficiency of 13-15% has been transferred to newly organized small enterprises for further development, namely, VIEN (Moscow), Geliotekhnika (Pinsk), and Geliotekhnika (Kokchetav). To obtain cheap silicon suitable for solar elements there is a proposal to join with foreign firms to create large scale production of polycrystalline silicon (up to 5000 t/yr) using direct carbothermic reduction of silicon based on deposits of pure quartzites available in Russia.

Work is also underway to create and organize production of photoconverters based on amorphous silicon and thin-film photoconverters based on A_2B_6 structures.

Two technologies have been created to obtain amorphous silicon. The Saturn scientific production enterprise precipitates films of hydrogenized amorphous silicon in a high-frequency glow discharge plasma onto a silicone glass substrate with the formation of a *p-i-n* structure and the creation of integrated photoconverters using laser scribing. There are plans to create in 1996 an experimental industrial line to produce photoconverters of this type with a production level of 1 MW/year. The achieved efficiency of photoconverters has reached 4.7-6.0% for a 10x10 cm area. Modules of these photoconverters may be used for calculators, electronic radio devices, watches, and other low-power consumer goods.

Kvantempagro MGO, with the Solarex firm (USA), has created an automated flexible production line for photoconverters, a steel band using continuous technology with a productivity of 2 MW/year. The line is planned to start up at the end of 1993. There are plans to reach a converter efficiency of 10-11%

In 1986-1990 in Krasnodar krai, the lead organization, Saturn scientific production enterprise, implemented a large-scale scientific and technical program to create and organize the production of new types of photoelectric modules based on single crystal or polycrystalline silicon. Work is continuing to create a series of photoelectric devices to provide electricity to autonomous consumers, as well as a number of combined hybrid systems which combine direct conversion of solar energy with other forms of nontraditional renewable sources of energy. Implementation of this program has resulted in the production of four types of modules and a number of solar batteries based on single crystal, polycrystalline, and profiled silicon.

For the first time in Russia a technology has been developed for vacuum-thermal formation of photoelectric modules, as well as the corresponding technical equipment. The photoconverter is protected from the effect of the atmosphere by a flat front silicate glass with a small amount of iron oxides, a back layer of modified PET-3 film and a hermetic sealing layer which uses films of polyvinyl butylate.

The basic photoelectric module, Start BS-1, was produced with output voltages of 8, 0, 12, and 22 V, a rated module power output of 38 W, dimensions of 1030x457x38 mm, weighing 8.5 kg, and with a photoactive surface area of 0.37-0.4 m^2 depending on the size of the photoconverters used. The maximum filling coefficient is 0.85.

The Start BS-3 photoelectric module was developed specially for use on the roofs of buildings. It can be a roof and a source of electricity, which simplifies the construction of the photogenerator and makes it possible to place it at an optimal angle to the horizon depending on the location of the building. The module uses a resin hermetic gasket to attach it to the roof frame. The electric switching system of the modules is placed in an attic room, which protects it from the effects of the atmosphere. This module is identical in its electric characteristics to the Start BS-1 module.

About 90% of the energy which falls on the surface of a photoelectric module is scattered in the form of heat, so increasing its equilibrium temperature may collect this heat. The Start BS-1 module was used to create a photoheat collector, the KFK. The collector is a flat photoelectric module, and on the back side there is an aluminum heat exchanger. The distance between the silicon photoconverters and the heat exchanger is about 1.5 mm, which provides a small amount of thermal resistance. Collection of heat from the photoconverters reduces the working temperature of the module and increases the electric power it provides by 0.5% for each degree of drop in temperature. It is expedient to use this type of collector in autonomous energy systems where the consumer requires electricity and heat. The heat carrier is deionized water or a solution of ethylene and propylene glycol. The KFK module has an electric power output of 38 W, a rated voltage of 16.2 V, a thermal power of 160 W with a heat carrier temperature of up to 50°C.

A Start BS-40M photoelectric module has also been produced with a power output of 47 W, a rated voltage of 16.2 V, and a weight of 7.5 kg. There is a Start BS-5-01 photoelectric module with a power output of 24 W, a rated voltage from 15 to 17 V, and a weight of 5.4 kg intended for use in moderate and tropical climates.

These modules may be used as independent sources of direct current or as part of other installations with appropriate schemes.

FES-U modular photoenergy systems have been developed and delivered to consumers which are intended to provide power to autonomous users far from centralized energy grids, for example, repeaters, lighthouses, distillation installations, water pumps, etc. The FES-U system has 90 models with a range of power outputs from 0.06 to 3.0 kW, a DC output voltage of 12, 24, 36, 60, and 120 V, the necessary number of start BS-1 modules, a protection device and backup batteries of various types.

The FES-PO is intended to supply energy to mobile homes and dormitories, for example, for construction or agricultural workers. Depending on the customer's requirements there is a photogenerator with a power output of 1.5-3.5 kW, and AC voltage output of 220V. The unit comes with a back-up battery.

Among the combined hybrid systems that have been developed one should note the FVES-D photo-wind-diesel unit, which includes: a 10 kW photogenerator, two wind electric generators, 4 kW each, a back-up 10 kW diesel generator, and a battery. This installation has been used on Sober Mountain in Krasnodar Kray to provide electricity to the repeater. In unfavorable weather conditions the diesel generator is automatically activated. It is estimated that the diesel generator will work in this location no more than 15 days per year.

At the Caucasus State Biosphere preserve the first experimental photohydroelectric plant, the FGES, has been built with a photogenerator with an output of up to 10 kW and a micro hydroelectric plant of the same power output, supplied by the hydroenergy of mountain streams. Optimal control of the operation of the FGES is provided by a mode switch and the use of back-up batteries, which are charged by the photogenerator of the micro-hydroelectric plant.

Production of consumer products and medical equipment based on photoelectric converters has also been organized.

The solar modular battery, the BSM, is intended to power semiconductor consumer radio equipment. The battery has an output voltage of 9.6 V, dimensions 147x181x12 mm, and weights 230 g. the output power can be increased by serial-parallel connection.

The Universal solar battery, BSU-1 is intended to provide electricity for consumer radio equipment, and to charge automobile batteries. The rated power output of this battery is 14.3 W with a working voltage of 9, 12, and 14.4 V.

The Karat solar battery is intended to power radio equipment and to charge batteries. It has a rated power output of 4-7 W, an output voltage of 12 V. It has two flaps which open to reveal the photoconverters. The dimensions are 430x196x13 mm and it weighs 0.6 kg.

The Utes solar battery is intended to provide electric power under field conditions and keeps working after a fall from a height of 0.5 m, submersion in water, jolts, and vibration during transport. It has a power output of 20 W, an output voltage of 15.6 V, weighs 6 kg, and has deployed dimensions of 1250x370x30 mm.

The Geliotok is intended for use in medical practice for microcurrent electrophoresis to treat and prevent a large number of illnesses. It can be used for diseaseless and sterile introduction of medicine instead of injections.

In the settlement of Chernomorskiy in Krasnodar Kray in the framework of the aforementioned program there are plans to build the Solnechnyy microregion, where there will be up to 37 different objects with electric power supplied from photoenergy systems and nontraditional renewable sources of energy of different types. Due to a funding shortage these plans have not been fully carried out. Five cottages were built with 4 kW generators on each of their roofs. Reliable supply of electricity to consumers is provided by parallel operation of the photogenerators with an external electricity network which uses inverters. Each house has an electricity meter which records the energy produced by the photogenerators and the energy consumed from the network. During the day the excess electricity is sent to the network. The specific average daily production of electricity over the course of a year was 2.5 kWhr per 1 kW of rated power, which met the needs of the families living in these homes.

In Blue Bay in the city of Gelendzhika, the Saturn Scientific Production Enterprise has constructed and is using an experimental industrial 30 kW photoelectric plant connected to a network. The energy from this plant is used to cover the peak daytime loads of the research laboratory of this enterprise.

For the low power needs of rural consumers, the All-Union Scientific Research Institute for Agricultural Electrification has developed and begun mass production of autonomous portable photoelectric plants, the FES-5,FES-25 and FES-150.

The nominal power output of the FES-5 is 2 W, with a voltage of 9 V. It is intended to power the pulse generator of an electric fence surrounding a pasture for grazing cattle.

The rated power output of the FES-25 is 8 W, with a voltage of 6, 9, or 12 V. Th unit is equipped with a battery and built-in lamp. It is intended to supply electricity to autonomous consume .s with an electric consumption level of 25 Whr/day

The FES-150 unit is intended to provide electricity to autonomous consumers with electricity needs no greater than 150 Whr/day. The control unit provides a DC voltage of 6 and 9 V with a power output of 5 W, and 12 V with a power output of 7 W. The unit is equipped with a battery, luminescent lamp, and inverter to obtain 220 V AC voltage. This station may power equipment to distill water from open uncontrolled sources.

To conduct experimental studies, and verify various types of photoelectric modules, special helio-electric equipment and developments based on the experience of using high-power photoelectric units, the Krzhizhanovskiy Energy Institute and the Rostov thermal electric power plant have begun design work for an experimental-industrial photoelectric unit with an output of 1.5 MW. The construction period for this unit in the Kislovodsk region will depend on the appropriation of the necessary funding.

Evaluating as a whole the state of photoenergy in Russia, one can state that at present Russia has accumulated the necessary scientific and technical reserves to be able to predict an economically expedient production-technological method will substantially expand the volume of production of photoelectric systems. There is is every reason to believe this, including the estimates of experts that the demand for photoelectric systems in the near future will reach 1 GW per year, or 10 million m^2 of photoconverters. At the level of scientific and technical developments in Russia, results have been obtained which correspond to achievements in other parts of the world. However, there is a significant lag in the volume of production and the use of photoelectric systems, particularly thin film systems. At present the world volume of production of photoconverters is 60 MW. One cannot compare this level of production with production in Russia.

The dynamics, structure, and possible production of the production of photoconverters in Russia is presented in Table 1 based on expert evaluations obtained at scientific research organizations working in this field.

Table 1.

Type of photoconverter	Volume of production, MW		
	1990	2000	2020
Single crystal silicon	0.5	15	30
Polycrystalline silicon	0.2	3	40
Amorphous silicon	-	4	40
GaAs	-	2	10
Thin film, etc.	0	2	10
Total	0.7	26	130

The predicted changes in the cost and efficiency of various types of photoconverters in Russia are presented in Table 2. The cost of converters is given in US dollars because it is difficult to estimate cost in rubles due to the high inflation.

Table 2.

Type of photoconverter	Cost, $/W				Efficiency, %			
	1985	1990	1995	2000	1985	1990	1995	2000
Single crystal silicon	12-15	6-8	3-4	2-3	8	12	14-16	18-20
Polycrystalline silicon	6-8	4-6	2-3	1.5-2.5	7	10	12	16
Amorphous silicon	-	-	2	0.5	3	4.3	12	15-18
GaAs	2	1.5	1	0.8	18	20	25	28-30

Note: 1. Conversion of the cost in rubles to US dollars in 1985 and 1990 was done with the appropriate exchange rate; 1995 and 2000 by projected estimates.
2. GaAs photoconverters consider the use of solar radiation concentrators.

The main direction of development of photoenergy in the future is expansion of the production of photoelectric converters and modules based on single crystal, polycrystalline, and amorphous silicon with a priority on thin-film structures.

In the technology of materials, development of the following methods is necessary:

- scrubbing of initial materials (silicon, gallium, indium, arsenic, phosphorous, cadmium, copper, etc.);
- obtaining cheap "solar grade" silicon from natural pure quartzites with direct carbothermic reduction of silicon and from nontraditional raw materials (rice husks, etc.);
- obtaining large blocks of polycrystalline silicon using the casting method for photoconverters with an efficiency of more than 13% and polycrystalline silicon films on cheap foreign substrates for photoconverters with an efficiency of 10%.

In the technology of producing photoconverters the following methods must be improved:

- cutting of slabs of silicon into plates and chemical dynamic polishing of large diameter substrates;
- scrubbing and heterogenation of substrate material;
- obtaining single crystal films of semiconductor materials by liquid, gas-phase, and MOS-hybrid gas-phase and vacuum epitaxy;

- gas-phase and vacuum sedimentation of polycrystalline semiconductor films on foreign substrates, diffusion acquisition of *p-n*junctions, and ion implantation using high energy particles;
- high-performance assembly of photoconverters into solar battery modules.

In the area of the creation and organization of production of new types of photoconverters, promising developments are photoconverters based on: cheap single crystal silicon with an efficiency of more than 15%, high-quality single crystal silicon with an efficiency of over 20%, silicon profiles with an efficiency greater than 12%, hydrogenized silicon with an efficiency of more than 12%, polycrystalline silicon with an efficiency of up to 15%, heterostructures (GaAs, aluminum, indium phosphide, etc.) with an efficiency greater than 25%, and heterostructural cascade photoconverters with an efficiency of more than 30%.

The economic situation in Russia currently does not foster the development of photoenergy, but in the near future one can hope that the difficulties will be overcome, and we should predict successful development of this field. However, the resolution of this problem requires large investments in scientific research and development work and investment in the development of production and the corresponding infrastructure.

Selective Coatings for the Main Units of Solar Photoelectric Stations

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[Article by M. M. Koltun, Krzhizhanovskiy Energy Institute; UDC 621.472]

[Annotation] This paper examines the optical and thermophysical characteristics of selective and protective coatings for condensers and photothermal generators and their effect on the efficiency of the conversion of solar radiation into electric and thermal energy. Requirements for these coatings are formulated. Means of obtaining them are described, and results are presented from in-situ testing. The optimization of the characteristics of solar elements used for photothermal installations with radiation concentrators is discussed.

[Text] In a selective examination of characteristics, even the most efficient semiconductor photoelements of a system (a solid solution of aluminum in GaAs), GaAs, it becomes clear that with a spectral sensitivity at $\lambda = 0.5$-0.9 μm, these photoelements are not photoactive to more than 50% of the solar radiation in the intervals $\lambda < 0.5$ μm and $\lambda > 0.9$ μm. It is this region of the solar spectrum, 0.5-0.9 μm, which is not converted into electricity, and which, in the final analysis, goes to useless lost heat. This situation leads to the idea of initially creating cascade photoelements with a spectral sensitivity over the entire range of the solar spectrum, and more recently, to a need to develop combined photothermal systems in which solar energy is usefully converted into heat and electricity at the same time.

At present, not only have projects for photothermal systems been created,but also an experimental working model of this type of system has been constructed, the solar house at the Institute of Direct Energy Conversion at the University of Delaware in the US. On the roof of this house are collectors made of thin-film solar elements of a CdS-Cu_2S system. The electricity which is produced is used for lighting and powering electric appliances in the house. The elements are protected from the environment by plate glass. Behind the elements are metal pipes through which air is pumped. The air takes on the excess heat of the solar elements, is heated and enters a system to heat the house. Thus the solar elements supply the experimental house not only with electricity, but also heat.

However, the total efficiency of the collectors with solar elements is no greater than 50%, undoubtedly due to a lack of optical optimization of the receiving surface of the solar elements.

In this case solar elements play the role not only of an electricity generating device, but also a selective surface, which should, in order to increase the total efficiency, have a very low coefficient of intrinsic thermal radiation ε. At the same time, gluing the protective glass leads to an increase in the total coefficient of radiation of the surface of the photoelements.

This example shows that special requirements are made on the optical surfaces of combined solar energy converters, and the selective surfaces of converters of this type should be examined separately.

It is also important to note that in combined converters, the issue of optical optimization of the surfaces of the solar radiation concentrators-reflectors, radiators-coolers, and transparent thermal insulation become very important.

Protective and selective coatings of solar radiation concentrators

Selective coatings of solar radiation concentrators are applied not only to obtain the necessary surface optical properties, but also to protect the reflecting layer from the effect of the atmosphere. When the concentrator is in thermal contact with the photoconverters or cold solders of the thermal electric generators, the coatings should also increase the total coefficient of intrinsic thermal radiation of the concentrator surface (while retaining a high reflectivity in the solar part of the spectrum). Consequently, the concentrator may be used simultaneously as a reflector and an effective radiator. Stable coatings for concentrators may be obtained using one of the following methods.

- Electrochemical anodizing of polished aluminum (or application of an aluminum film in vacuum) to obtain a layer of Al_2O_3 on the surface. The anode film has high moisture resistance and low porosity, and increases the ε of aluminum from 0.04 to 0.8. The quality of the coating, however, depends greatly on the electrochemical processing.
- Evaporation in vacuum of protective layers of SiO_2, SnO_2, Al_2O_3, and SiO. The coatings may be applied on any reflecting surface and increase ε to 0.8; however, they have relatively weak adhesion and are porous. The SiO film has significant absorption in the shortwave part of the visible spectrum and in the ultraviolet. At a thickness greater than 2-3 μm a coating obtained by evaporation in vacuum peels away from the surface due to large internal stresses.

- Application of transparent silicon-organic lacquers which are resistant to ultraviolet rays and changes in temperature. These coatings may be obtained on virtually any surface. They have good cohesion, and at l = 15-20 μm increase the ε of aluminum to 0.95. Their drawback is a lower resistance to light than, for example, anode films, and rapid accumulation of dust during use.

Studies have shown that coatings based on polysiloxane and polysilazane lacquers have these drawbacks to a lesser extent. For a thin layer (5-10 μm) these lacquers are completely transparent in the ultraviolet region of ground-level solar radiation (λ = 0.28-0.4 μm).

Application of a reflecting layer on the internal surface of polished glasses with additional protection of the back side with lacquer composites. This method is mainly suited to relatively small concentrators; however, one important advantage is that the reflection of the concentrator in the ultraviolet may be regulated by changing the glass composition. Thus, in work with boron-silicate glass K-8, radiation with $\lambda < 0.36$ μm is completely absorbed by the glass, and the concentrator does not reflect ultraviolet rays. In work with glass LK-8 or with quartz they are virtually unabsorbed and will be radiated. This property of these concentrators can be used to irradiate seeds, and to treat patients with doses of solar light of a specific spectral composition. When a triangular facet of these reflectors is used one can make concentrators with a large surface.

It is probable that complete solution of the problem of protecting reflecting surfaces will be reached using a combined method, for example, anodizing and application of a layer of lacquer or joint use of anodizing and vacuum evaporation.

The anodizing method and vacuum evaporation are used to obtain optical coatings for concentrators has been rather well developed; application of polymer coatings (especially when they are used not only as protective, but also as selective coatings) has received relatively little attention.

The requirements on the optical and mechanical properties of the polymer coatings of concentrators are complex and varied.

1. The absolute transparency in the entire spectral region of solar radiation is from 0.2 to 2.5 μm. From the point of view of coating durability, transparency in the ultraviolet is important, because this radiation has a fundamental destructive effect on polymers. Moreover, in some cases, as already noted, a high coefficient of reflection is needed in the ultraviolet.
2. Complete absorption of infrared radiation (3-30 μm) is needed to increase the coefficient of intrinsic thermal radiation of the concentrator surface. When the surfaces of modern concentrators are large, the thermal balance of the solar energy converter depends significantly on the heat of intrinsic radiation given off by these surfaces.
3. Good adhesion to the reflecting layer, the absence of pores, and elasticity at low temperatures. These requirements are frequently mutually exclusive and require the selection of the optimal coating thickness.
4. Simple application and low cost.

Considering the limited resistance to ultraviolet radiation and atmospheric effects of a number of polymers, in order to satisfactorily meet the requirements listed above, one must not only select materials, thicknesses, and application techniques, but one must also conduct prolonged light and weather testing of the coatings in southern regions of Russia with careful measurement of the optical characteristics of the protected concentrators before and after aging. In prolonged use of solar energy reflection from their surfaces decreases significantly due to the effect of solar radiation, humidity, temperature changes, and abrasion by grains of sand.

Preliminary laboratory studies of transparent polymer coatings based on polyvinylbutyral, polyacrylate (D-4), copolymer of vinylbutine ether with methylmetacrylate (SVM-31), butylmetacrylate (BMK-5), alkadiene acrylate (AK-11), polymethylphenylsiloxan and butylmetacrylate (KO-538) revealed that for a change in temperature from -50 to +90°C the lacquers PVB, D-4, SVM-31, BMK-5 peeled off with the applied films of silver and aluminum on the surface of the concentrator. Lacquers AK-11 and KO-538 held up to this testing. The coating remained durable with good adhesion to the specular surface (for a lacquer layer thickness l no greater than 25 μm).

Thus, a silicon-organic lacquer, KO-538, and an alkyd-acrylic lacquer, AK-11, were selected for in-situ testing. To increase light resistance 2.2'-dioxy-4.4'-dimethoxybenzophenon and 2.2'-oxy-4.4'dioxybenzophenon were added. These coatings were applied with a brush or sprayed over a reflecting layer of silver precipitated galvanically on copper strips 0.1-0.15 mm thick. The large number of broad absorption bands in the infrared, which is characteristic of organic and silicon-organic compounds, and the layer of transparent lacquer, which retains the high reflection from the silver in the solar spectral region, sharply reduces reflection from the surface in the 2-25 μm region, which is clearly visible in Fig. 1. Measurements were made with an IKS-14 infrared spectral photometer with an attachment for measuring specular reflection.

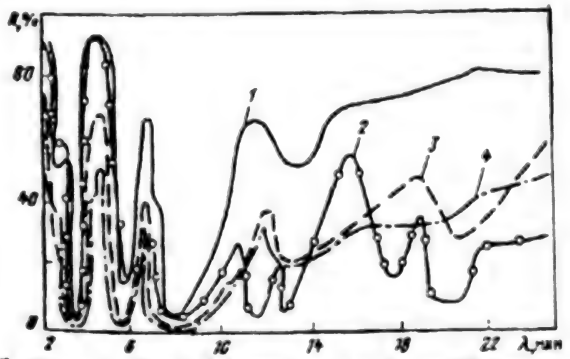

Figure 1. Spectral dependences of the coefficient of reflection of the concentrator surface with a reflecting layer of silver covered with lacquers.

Key: 1. AK-11 (l = 4-6 μm; 2. KO-538 (l = 20-22 μm; 3. AK-11+1% 2-2'-oxy-4-4'dioxybenzophenon (itall = 16-22 μm); 4. AK-11+1% 2-2'-dioxy-4-4'-dimethoxybenzophenon (l = 12-18 μm). X-axis, λ, μm; Y-axis R, %.

The spectral curves are given for those values of l at which the lacquer layer remains mechanically durable during testing for light aging and thermal cycling. As the thickness of the lacquer layer increased, reflection at $\lambda > 2$ μm was extinguished more strongly, but this, unfortunately, is unacceptable for concentrators in practical use because adhesion worsens as the thickness of the coating l increases. For the relatively small thickness that we selected ($l \leq 25$ μm) the lacquer itself has one more drawback: absorption in the ultraviolet region of the solar spectrum at ground level (0.28-0.4 μm) is virtually absent. When lacquer coatings of this thickness are applied on an aluminum film precipitated by evaporation in vacuum on polished glass, one can obtain a surface with good reflection in this region of the spectrum, and simultaneously, a surface which is well protected from mechanical and atmospheric effects (the silver substrate to reflect ultraviolet rays cannot be used due to the low reflection of silver at $\lambda < 0.38$ μm).

The better reflective properties of aluminum covered with lacquer are obvious in Fig. 2 when compared with concentrators protected by films of SiO and SiO_2 obtained by vacuum evaporation. Until recently this was the most well-developed method of protecting mirrors from the effect of the atmosphere. Measurements were done with an SF-4 spectral photometer with a PZO-1 attachment.

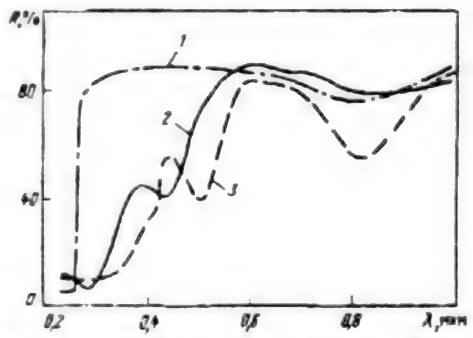

Figure 2. Spectral dependences of the coefficient of specular reflection of a concentrator surface with a layer of aluminum and various coatings.

1. KO-538 lacquer (l = 20-22 μm); 2. SiO_2 (l = 2 μm); 3. SiO (l = 1 μm). X-axis, λ, μm; Y-axis, R, %.

In addition to the spectral coefficients of reflection, the FM-59 photometer measured the total coefficient of absorption of solar radiation α_c (at 0.25-2.5 μm). The FM-63 thermal radiometer measured the total coefficient of intrinsic thermal radiation of the surface ε at 25°C (at 4.0-40 μm). Models of concentrators were manufactured with AK-11, AK-11 + stabilizer, or KO-538 lacquers 5-25 μm thick; the viscosity of the lacquers was varied, as was the number of layers applied. Laboratory testing of the resistance to temperature changes and measurement of the initial optical coefficients α_c and ε made it possible to select the samples with the optimal thickness. These were subjected to light aging in southern regions of Russia for 16 months.

The results of determining the total optical coefficients of the concentrators before and after aging showed that the smallest ratio α_c/ε = 0.16-0.17 was obtained for a coating of silver with a layer of KO-538 lacquer. This coating is distinguished by the highest stability of optical characteristics during use. Its exterior remained virtually unchanged during the 16 months of exposure in Gelendzhik. Coatings of KO-538 lacquer also successfully protected concentrators with a layer of aluminum obtained in vacuum evaporation. It is easy to clean dust and pollution from these coatings because they may be cleaned with cloths, wet with water or alcohol. The lacquer is technologically efficient: a 20-25 μm coating is applied with a sprayer in two coats with a viscosity of 14-16 s as determined by a VZ-4 viscosimeter. It is dried at room temperature for 2-5 hours. The AK-11 lacquer yellowed; its transparency worsened by 15-20% in the visible region of the spectrum. The addition of benzophenone derivatives does not yield the expected effect of stabilizing the properties of the coating when it is affected by ultraviolet radiation. This, apparently, may explained by insufficient purity of the stabilizing additive. The AK-11 lacquer is less technologically efficient. It is dried at a higher temperature (100°C) and is not as hard as KO-538 (0.55 and 0.7 on the MG-4, respectively.

From the information presented above it follows that a transparent silicon-organic coating of KO-538 lacquer 20-25 μm thick may be recommended for use on a large scale. This coating should be applied on aluminum or silver reflecting layers on the surface of the concentrators.

Just as promising for protecting the surfaces of concentrators and giving them selective properties are polymer transparent coatings based on silicon-organic polysiloxane and silazane lacquers tested during the studies.

However, the results of our investigations showed that concentrators with an external reflecting coating should be used only in installations with a relatively short service life, about 3-5 years.

For solar power stations, at present the most reliable concentrators are those with a back reflecting coating.

Coatings of photothermal converters

In the development of coatings for typical solar elements, one of the key goals is minimization of the equilibrium working temperature; when solar elements are used in photothermal converters, it is necessary, conversely, to take measures to increase the amount of heat absorbed by the photoelement. Naturally, effective heat carriers should be used to transfer the collected heat into the system. The rate of heat removal must be held at a level so that the temperature of the photoelement does not exceed acceptable values to obtain a sufficiently high efficiency of photoelectric conversion. In other words, in photothermal converters the photoelements form a collector surface and are simultaneously used as photoelectric generators and as selective black-white coatings to obtain the highest efficiency of conversion of solar energy into electricity and heat.

As follows from the studies of optical characteristics of solar elements, due to the large concentration of free charge carriers in a strongly doped surface layer of photoelements, the ratio α_c/ε for a clean polished surface, for example, silicon photoelements without coatings, is 3-3.5, and after application of a one-layer anti-reflection coating (without an upper layer of glass) increases to 5.

It is obvious that for photothermal converters one should use this very type of photoelement with an anti-reflection coating without glass. To decrease convective heat losses it is useful to place the photoelements in an evacuated flat or tubular glass pipe. The pipe can have transparent selective coatings with a high coefficient of reflection in the infrared on the internal surface.

It is also possible to further increase the α_c/ε of the surface of the photoelements. One can use multi-layer coatings applied directly on the surface of the photoelements.

The absorption of aluminum films about 100 Angstroms thick is about 10% in the region of spectral sensitivity of the photoelements; silver films of this same thickness reach 25-30%, and, consequently, in effective coating of the upper and lower boundaries of the semitransparent metal film its transparency may be 70-90%.

At the same time, due to the low coefficient of intrinsic thermal radiation of the metal films for the surface of photoelements with a multi-layer coating consisting of a semitransparent metallic layer coated on both sides by dielectric films, α_c/ε can be increased to 18, as is shown by experiments. Coated solar elements with a Schottky barrier formed by silicon with thin films of chromium and copper or GaAs with a semitransparent gold film reach this high ratio level.

Calorimetric measurements done in a laboratory near Gelendzhik showed that for silicon photoelements with selective coatings with a ratio α_c/ε 15 attached to copper tubing with cooled water mounted in an evacuated glass pipe one can obtain a total efficiency of conversion of solar energy into electricity and heat of 75-80% (10-12% into electricity, and 65-58% into heat) for an active photoreceptor surface.

Optimization of the electrophysical characteristics of solar elements intended for photothermal installations with radiation concentrators

The parameters of solar elements of any semiconductor material with a high initial efficiency measured for a single extra-atmospheric or ground-based exposure to illumination worsen sharply as the concentration of solar radiation increases, if its serial resistance is 0.5-0.6 O cm^2, which is characteristic for the majority of elements used to create solar batteries with the typical construction. Even for relatively small values of the coefficient of concentration (C = 20-50), at which the use of thermal and photoelectric solar radiation converters with selective coatings is especially effective.[1], the losses in efficiency and electricity generated by solar elements may be so large that the use of combined photothermal installations and collectors with concentrators becomes inappropriate both in terms of power and economics. One can maintain the high initial electric parameters and efficiency of high-quality solar elements while increasing the degree of concentration of incident radiation if one coats the surface of the thin upper doped layer of elements, which has the greatest effect on serial resistance, a dense contact lattice with optimal band dimensions, and on semitransparent metal layers (illuminated from one or both sides), sharply decreasing the surface layer resistance of the doped region.

The parameters of solar elements intended for use in increased radiation intensity conditions were optimized for elements with a two layer structure of the doped layer. In surface layer I the concentrations of dopants N_1 is constant, and in region II adjoining the p-n junction, there is an exponential distribution of dopants N_2 corresponding to a constant built-in electric field. At the boundary of regions I and II there is a potential jump equal to $\ln (N_1/N_2)\, kT/q$.

This model rather accurately describes the experimental distribution of dopants in a doped layer obtained using modern methods of diffusing dopants into silicon, especially with diffusion through a previously created anode film with a controlled porosity. It is assumed that the base region is homogeneously doped. The dependence of mobility μ and the diffusion length of carriers on the concentration of dopants N is considered by introducing an exponential relation $\mu \sim N^{-1/2}$. The collection coefficient is calculated using formulas analogous to those presented in Ref. 2. The difference is in the consideration of a large number of parameters of real solar elements, for example, the finite speed of surface recombination and the concentration of charge carriers in the base region.

Both methods of reducing the serial resistance R_s of elements (the creation of a dense contact lattice and application of multi-layer coatings including a semitransparent metal layer) have been used to obtain models of solar elements. These models have been manufactured specially to compare the theoretical calculated dependences with experimental ones (Fig. 3), and agree rather well. At R_s 0.1 O cm^2 the maximum efficiency is reached for a 20- to 50-fold intensity of radiation. The parameters of these elements and the nature of defects in them were studied with the method presented in Ref. 3.

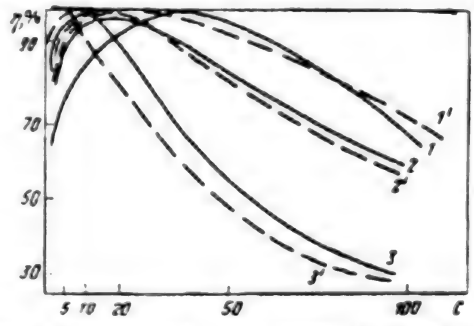

Figure 3. Comparison of experimental (1-3) and theoretical (1'-3') dependences of the efficiency of silicon solar elements on the degree of concentration of incident radiation C (condition AM1.5) for different values of serial resistance.

Key: 1, 1'. 0.1 O cm^2; 2, 2'. 0.2 O cm^2; 3, 3'. 0.5 O cm^2.

The measurements taken under conditions AM1.5 demonstrate that for a 30-70-fold intensity the efficiency of these elements is 12-13%.

Thus, as a result of the studies which were conducted, silicon solar elements were created and studied which use optimized electric and optical parameters for use with increased concentrations of solar radiation in photothermal receptors of solar photoelectric stations, for example, in the 1.5 MW solar station planned for the city of Kislovodsk.

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Nontraditional Energy at the Solntse Scientific Production Association

947F0125A Moscow TEPLOENERGETIKA in Russian No 2, 1994 pp 46-52

[Article by R. B. Bayramov, A. A. Petrova, Solntse Scientific Production Association, Academy of Agricultural Sciences of Turkmenistan; UDC 662.997]

[Annotation] Domestic and world experience in the creation of equipment which uses renewable forms of energy is analyzed. A concept is developed for comprehensive use of nontraditional and traditional sources of energy. Schematics are given for new equipment and technologies created from this concept. Operating, thermotechnical, and economic specifications are presented. [Text] The attention of scientists and specialists all over the world is being focused more and more on the problem of using renewable forms of energy, including solar energy.

In 1979 in the system of the Academy of Sciences of Turkmenistan, an Institute of Solar Energy was organized. The Solntse Scientific Production Association was created at this institute in 1980. An entire cycle of research in the use of solar energy, from scientific studies to the introduction of the results of experimental research and design work into production, has been planned.

The work is being carried out in the framework of state scientific and technical programs directed at: more complete use of renewable sources of energy in the fuel and energy balance of the country; academic programs on the biosphere, ecology, and a fundamental increase in the efficiency of energy systems; a Comprehensive Program for Scientific and Technical Progress to the Year 2010, as well as work in the framework of the Coordinated Plan of Scientific Research of the countries of Central Asia and Kazakhstan on the use of renewable sources of energy in the economy.

The scientific activity of Solntse in the Academy of Agricultural Sciences of Turkmenistan encompasses a triad of heliotechnical science: fundamental research, applied studies, and equipment and technology.

A fundamentally new idea for comprehensive use of renewable forms of energy (the sun, wind, geothermal water, ground heat, waste heat, biomass, biogas, etc.) and traditional sources has been formulated to create progressive technologies and equipment.

World practice has been oriented toward the creation of individual energy installations, solar electric power stations with a large power output based on thermodynamic cycles or photoelectric and thermoelectric converters. The construction of solar electric power stations on a broad scale is unrealistic because the cost of 1 kW obtained with these stations costs more than 5000 rubles for any sovereign state (the cost is given in 1984 prices).

Based on many years of fundamental and applied studies, Solntse has put forth a concept for the development and creation of lower power consuming wasteless ecologically clean complexes with various purposes with combined use of nontraditional and traditional sources of energy. This reveals the possibilities for creating alternatives to traditional power engineering for providing power and water to industrial and agricultural facilities, as well as serving as a centralized aid to vital activity in arid zones as autonomous production units based on solar equipment.

The concept was used to develop a generalized mathematical model of an autonomous sheep raising solar complex as a single production facility, as well as an algorithm for its design.[1,2]

The operation of the complex is examined as a complex system consisting of a set of controlling subsystems (subsystems of water and power supply) and executive subsystems (consumption subsystems: a residential unit, a feed unit, etc.) and includes simulation. The model considers many factors, such as the dynamic interconnection of elements, the presence of uncertainty, a set of interchangeable variants of elements, and the stochastic characteristic of nature. It makes it possible to determine the most effective mode of operation of the complex over any hypothetical year with minimal expenditures and with complete satisfaction of the resource demands of the facility, including the production of food. There is optimal distribution of the area of pasturing by seasons, and the emergency supply is determined as a function of the combined agricultural and meteorological conditions in a given year.[3] The method of evaluating the productivity of desert pastures was introduced in the Turkmen UGKS [expansion not given]. At the hydrometeorological Center of Turkmenistan a program was introduced to predict the harvest of raw cotton, which was compiled on the basis of the main points of the generalized mathematical model of the operation of the autonomous sheep raising solar complex.

The autonomous sheep raising solar complex has no analogs in world practice[4] and is a new technology for using desert pastures with stationary flocks of sheep. It is based on efficient use of natural resources and renewable sources of energy while maintaining the ecology of the environment.

Two experimental-industrial sheep raising solar complexes have been constructed in the central Karakum region (at Cherkezli and Ovez-Shikh).

One possible design is presented in Fig. 1.[5,6] The main designs, thermotechnical and economic specifications of the Solntse installations in the complexes are presented in Ref. 7. Experience in constructing and using the complex has been accumulated and systematized. It has been proven that it works and is effective. Six years of interdepartmental testing was conducted at the complex in Cherkezli in the Geok-Tepinskiy region. The administration of the collective farm documents the good condition of a flock of 1000 sheep. Every year plans were implemented to shear fleece and to raise young stock.

The economic effect of the Saradzhinskiy sheep at the complex (Cherkezli) was 20,000 rubles per year. The expected economic effect of the Karakul sheep at the complex (Ovez-Shikh) is 50,000-60,000 rubles per year.

Two autonomous solar complexes were built for weather stations in the central Karakum region (Kara-Kul and Davali). These complexes have solar installations to provide heat and water to remote scattered consumers in desert territory.

There is design and budget documentation for the entire complex developed at Solntse. An experimental shop has been created and is in operation to produce solar distillers and other elements of polypropylene, with which the solar part of the autonomous complexes, as well as the combined solar systems and equipment, are equipped.

A comprehensive approach to the use of renewable sources of energy has received ever more recognition in domestic and foreign practice. Solntse has developed a number of other designs in this area, and they are protected by 28 inventor's certificates. At present many of them have been implemented in the form of components of autonomous solar complexes for various purposes at experimental bases of Solntse and in various farms in the republic. This primarily includes: a wasteless biological solar complex intended for simultaneous horticultural and poultry production in a single technological mode;[8] an autonomous solar meliorative complex to process collector- drainage water for local soil melioration;[9] an industrial wasteless

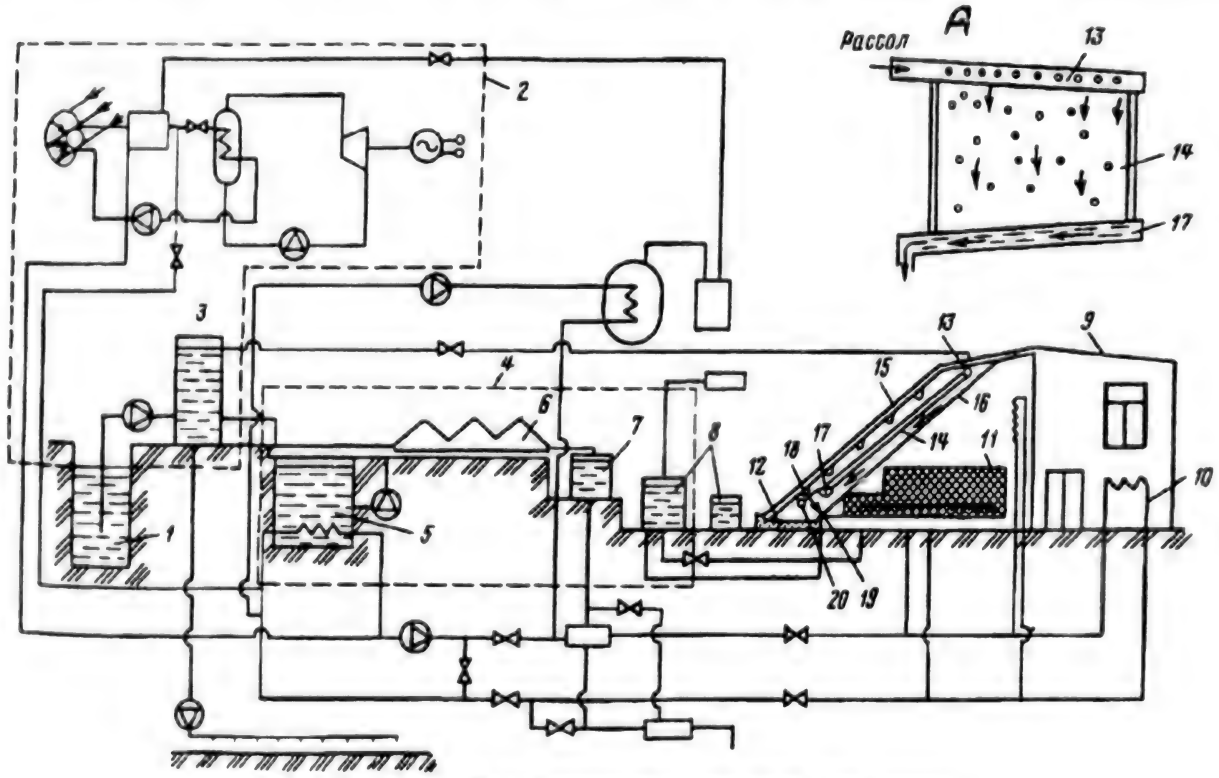

Figure 1. Schematic of the autonomous sheep raising solar complex.

Key: 1. salt water drain; 2,3. energy loop with biogas installation and battery; 3-4. device to obtain and collect distillate; 5. reservoir with transparent cover; 6. solar distillers; 7. distillate holder; 8. mixer; 9. house with solar hothouse; 10. heating system; 11. biological object; 12. basin with salt water; 13. hydraulic collector; 14. heat absorbing panel; 15. light transparent wall; 16. light transparent shade; 17-19. channel for brine and distillate; 20. input nozzle. a. brine.

solar complex to raise commercial fish;[10]; a wasteless animal husbandry solar complex with a technological line to raise Chlorella microalgae;[11] solar complexes to process agricultural products;[12] a residential- production solar complex for 500 families of the personnel of the Academy of Sciences of Turkmenistan; a residential- sanitary solar complex on the shores of the Caspian Sea; and an autonomous solar power complex.[13]

The comprehensive design provides for functionally interconnected operation of individual elements which use renewable and traditional forms of energy based on solar collectors (flat, parabolic-cylindrical and parabolic concentrators, focal lines, Fresnel lenses, and small format heliostats) to obtain electricity, heat, cold, and hot and distilled water at autonomous farms of various types in arid zones.

Comprehensive work to create wasteless technologies for the conversion of solar energy, biogas into heat, biogas and wind into electricity operating for the entire year in autonomous and nonautonomous modes may provide 70% of the demand for energy, and consequently, make solar energy a viable alternative to traditional energy which is destroying human habitat. In particular, the problem of restoring the ecological equilibrium of the Arals and improving the social and economic situation in the Arals region may be solved with nontraditional renewable sources of energy.

It has been shown[4] that widespread copying of wasteless technologies will make it possible to increase the sheep population by 2.6 million in Turkmenistan and by 15 million in Central Asia, including Kazakhstan. New territories will be opened up, primarily in areas of decentralized heat and gas supply, including a large part of Turkmenistan. A social problem will also be solved in these territories: there will no longer be a need for a nomadic form of life for herders, who for centuries have lived in the desert. A modern level of living and working conditions will be created. An increase in the scale of use of renewable sources of energy in these zones will make it possible to reduce the consumption of motor fuel used at present to provide electricity, heat and cooling. It will also solve the urgent social problems of raising the living conditions of the rural population, and it is a necessary condition for the replacement of the volume of organic fuel in the TER [expansion not given] balance of the country.

Solntse has developed scientific and technical foundations for low-potential solar technology in the area of processing agricultural products. A series of projects will be carried out to model and optimize modern heat-mass exchange solar equipment.[14]

Based on the numerical solutions of the problem of heat and mass yield in evaporation of a solution from a film surface, a mathematical model of a nonstationary temperature mode for a solar air-heater and accumulator has been developed which makes it possible to study the effect of structural, operational, and climatic parameters on the productivity of solar drying installations. A service life has been established and the efficient configuration of elements has been examined. The results of experimental studies of the nonstationary temperature mode of a solar air-heater and accumulator are presented in Fig. 2.

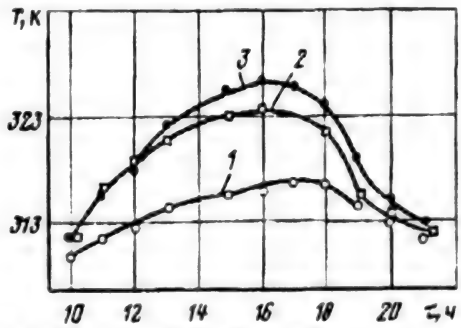

Figure 2. Dynamics of the change in temperature of a stream of air in a solar air-heater and accumulator.

Key: In a cross section $y = 9x10^{-2}$ m: 1. $x = 0.2$ m; 2. $x = 1$ m; 3. $x = 1.8$ m. X-axis: τ, hr; Y-axis, T, K.

Six fundamentally new original designs have been created for low potential solar installations to dry raw cotton, grapes, cucurbits (sun-drying of melons), herbs, and Karakul lambskin, and for heat and moisture processing of reinforced concrete products (Fig. 3). The originality of the designs is confirmed by inventor's certificates.[12, 15-17, etc] The main parameters of experimental and industrial and purely industrial models of solar drying installations are presented in the table. The total radiation reception surface of systems in use at farms in the republic is 8000 m^2. They all have gone through successful interdepartmental and production testing which indicated that they work, are economical in terms of energy, and ecologically clean. The use of solar energy is an important resource in the improvement of the provision of power to agricultural processing equipment. Traditional drying processes use 15% of the fuel of the total thermal balance of the country.[14]

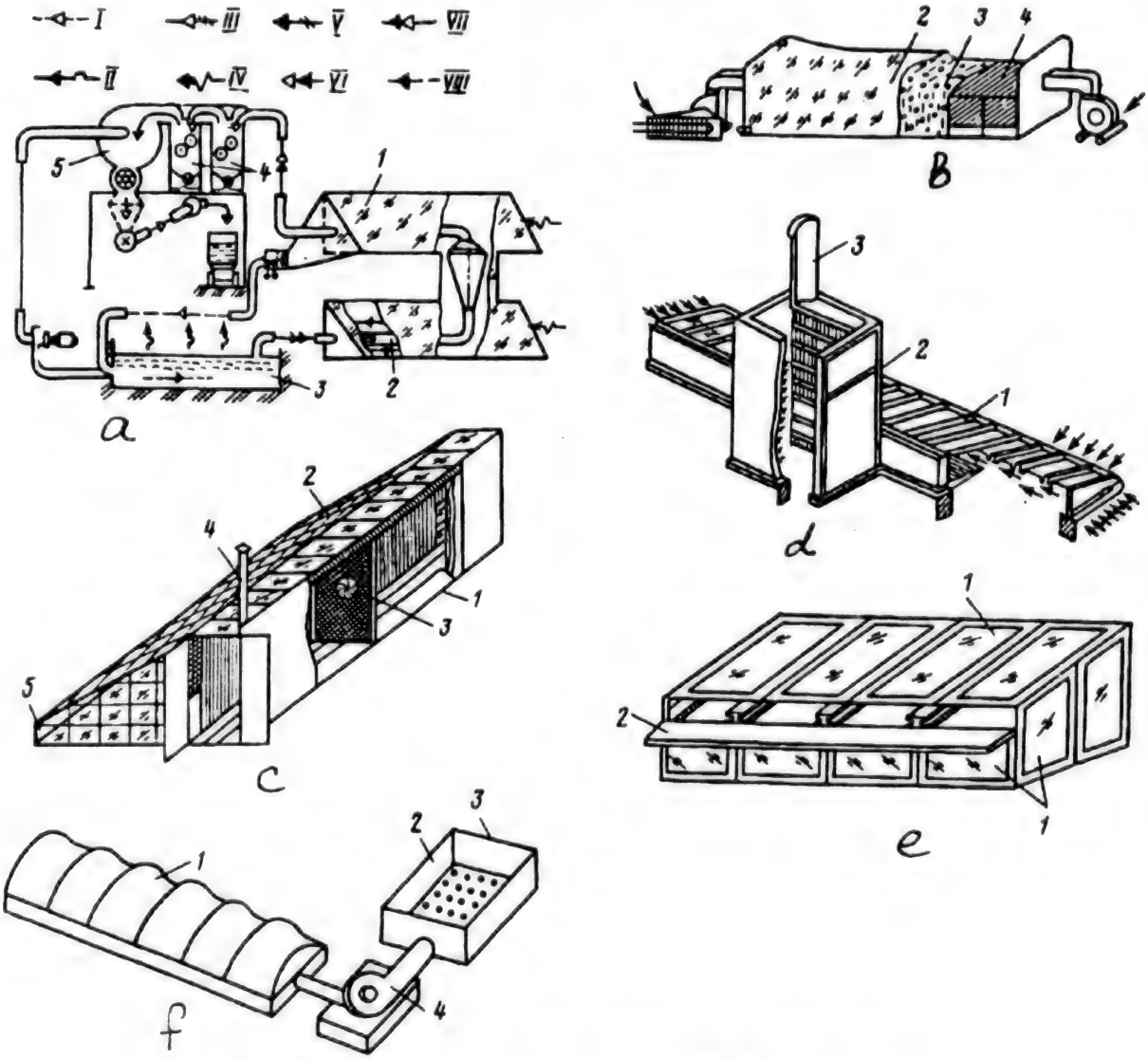

Figure 3. Schematic of solar drying installations for various purposes.

Key: a. combined pneumatic drying installation for drying and cleaning of raw cotton; 1. solar air-heater; 2. blackened pneumatic tube; 3. drying chamber; 4. weed cleaner; 5. separator; I. dried, cleaned, cooled cotton; II. moist air; III. dried, clean, heated cotton; IV. surrounding air; V. heated moistened air; VI. dried, weedy cotton; VII. preliminary dried, weedy cotton; VIII. heated dry air; b. convective installation with perforated radiation reception surface for drying Karakul lambskin: 1. drying chamber; 2. light transparent cover; 3. perforated opaque cover; c. installation for sun-drying of melons: 1. drying chamber; 2 solar air heater; 3 reversible ventilator; 4. exhaust pipe; 5. external air intake; x. blackened metal shavings (the product is placed on special racks-carts = rails); d. installation for sun-drying of melons, drying fruits, vegetables in field conditions; 1. solar air heater; 2. drying chamber; 3. exhaust pipe; e.solar dryer, hothouse: 1. closed glass enclosure with inclined roof; 2. vents from north and south sides of installation for loading and unloading trays with products; 3. guide brackets for trays (in drying vents are open - the steam-air mixture of the natural draft is removed from the north side; when seeds are being grown, the vents are closed); f. installation for drying bin products (grain, herbs, raw cotton, vegetables), as well as to remove excess moisture from vegetables (potatoes, beets, onions, etc.) before they are placed in storage:1. solar air heater of a polyethylene film with blackened heat-insulating bottom; 2. drying chamber with perforated bottom; 3. folding wall for loading and unloading; 4. ventilator

Main specifications of solar drying installations

Name	Area, m^2	Specific productivity in drying products	Estimated cost of installation, rubles	Quality of product (how it meets GOST)	Estimated time to recover cost, years
Solar cotton dryer	550	up to 4 t/hr	36,000	meets GOST	3-4
Solar drying area with heat collector for drying grapes	4200	0.3 kg/(m^2days)	(without cleaner)	Sort I 50%	3-4
		currants	30,000	Sort II 50%	
Solar installation for drying melons	80	0.8-1.0 kg/(m^2days)	7,000	Sort I 100%	2-4
		dryed melons			
Solar installation for heat-moisture processing of reinforced concrete products	162	20 m^3/day	142,000	meets GOST	2-3

The expected economic effect of universal introduction of solar cotton drying installations (800 installations are needed to process the annual volume of raw cotton in the republic) is 20 million rubles as a result of saving fuel and freeing the manual labor of people occupied in drying. Drying of currants, for which collective farms spend 270 rubles per ton using traditional methods, saves 100 rubles per ton using solar energy. In Turkmenistan 10,000 tons of currants are produced.

Solar drying installations are used for sun-drying of melons, drying of raw cotton, grapes, Karakul lambskin, and reinforced concrete products at the Vakharman experimental farm, the Sayatskiy cucurbit state farm, the Leninizm Yely state farm, the Sotsializm collective farm, the Bakharden collective farm, and the administration of Turkmenselelektrostroy. The drying time is reduced by up to a factor of two, depending on the type of product and the heat and moisture processing of reinforced concrete

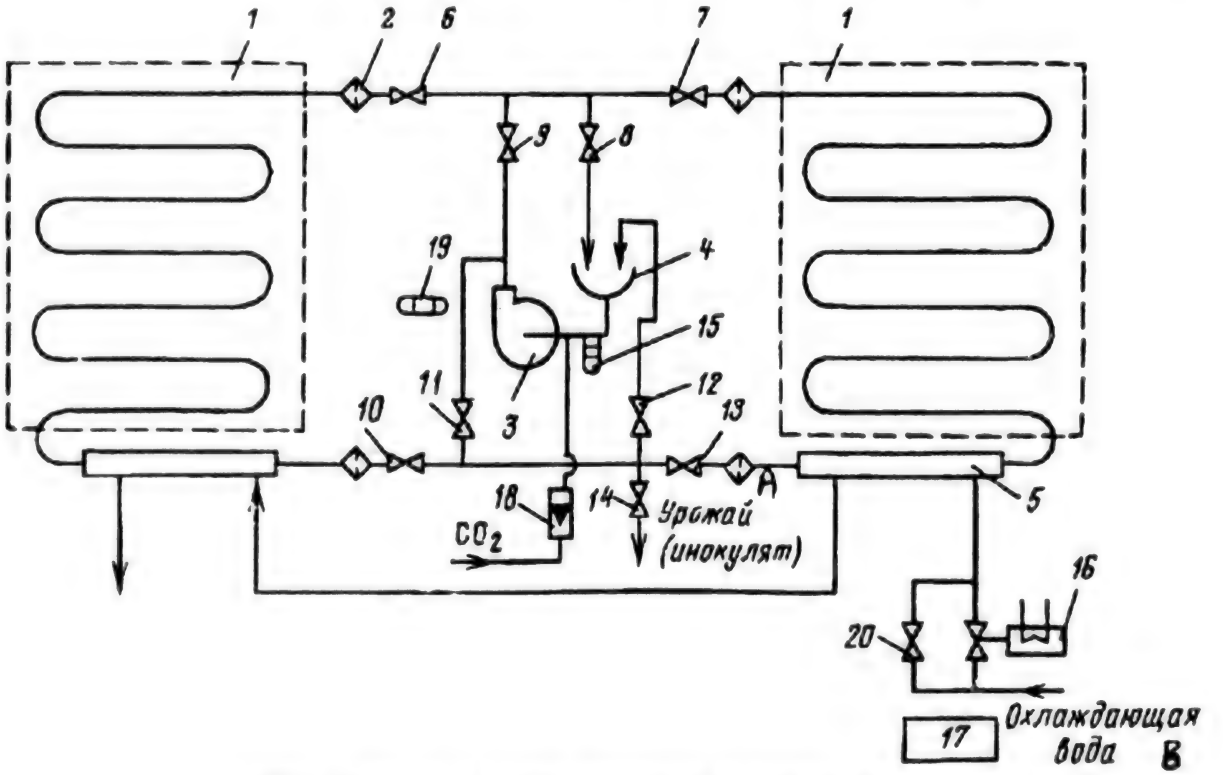

FIgure 4. Schematic of a typical photoreactor for industrial installations.

Key: 1. glass pipes of photoreceptor surface; 2. lint traps; 3. pump; 4. gas exchanger; 5. heat exchanger (tube in tube type); 6-14. regulating valves; 15. resistance thermometer; 16. electromagnetic valve; 17. temperature regulator; 18-20. doubler system for manual regulation of temperature of Chlorella suspension. a. crop (inoculate); b. Cooling water.

products. Product quality increases significantly and is guaranteed against industrial and other contaminants.

Thus, it is important to stress that low-potential solar technology is certainly an independent scientific and technical field in the area of the use of solar energy. It has important economic significance in maintaining agricultural production. There are presently enormous losses: in individual cases more than 20% of the product is lost.

Solntse, along with the Biotekhnika Scientific Production Association (Moscow) has studied for several years the raising of Chlorella microalgae using solar energy.[18] The results have made it possible to use a fundamentally new industrial technology for producing Chlorella with nonstationary irradiation conditions,[19] to create industrial installations at farms, and to begin construction of a factory to produce 25 tons per year of dry biomass of Chlorella based on a 1 ton per year line in operation at Solntse.

A typical photoreactor of industrial installations (Fig. 4) is 700 liters in size. The average daily production of the unit for five months (May-September) is 3500-3800 liters with a suspension density of $20x10^6$kl/ml. This photoreactor can be used at farms for livestock. The necessary power is provided by combining the appropriate number of typical units. A shop to breed Chlorella with a total photoreactor volume of 7.2 m^3 has been introduced at the 40 Years of TSSR collective farm and at the Kizyl-Arvat feeding complex.

The studies of many authors have established that the use of Chlorella as a protein-vitamin additive in the feed of agricultural animals helps increase milk and meat production and the egg production of chickens by an average of 30% with a simultaneous reduction in expenditures for feed of 20%. Gossypol poisoning of big- and small-horn cattle is prevented, and it is a prophylactic substance for jaundice in sheep.[18] To fully satisfy the needs of agricultural animals and poultry for the public sector of Turkmenistan, which contains 274,000 cattle, including 73,000 cows, the annual production of biomass of Chlorella should add up to 210,000 m^3 suspension with a density of $20x10^6$kl/ml to the protein-vitamin additive, or for dry Chlorella, about 420 tons per year. t is clear that the creation of industrial production of Chlorella biomass should be gradual and begin in feeding complexes.

Several domestic and foreign firms are interested in the production of factories to produce dry Chlorella biomass. In particular the Scientific-Commercial Medical Center of Russia is prepared to be a constant consumer of Chlorella (no less than 200 tons per year at a price of 20,000 rubles per ton). The time of the factories to pay for themselves in this case is no more than 3 years. In addition the organic fuel saved by a 25 ton factory module is 4000 tons of ideal fuel. Moreover, the products of the processing of dry Chlorella matter (protein hydrolyzate, Khlorin-Ye6) are in great demand in the consumer market in our country and abroad.

Considering this, industrial biotechnology using solar energy is a new and promising field which reflects the great opportunities for using microbiological synthesis products in the economy. This is a very important field. A joint venture, Khlorella, has been created. There are plans to place its products on the international market.

The range of developments at Solntse includes low-potential, moderate and high-temperature solar energy. In addition to comprehensive designs there are a number of other installations and equipment: solar water heaters, combined heat and cooling and hot water supply, passive solar heating systems, solar-evaporative conditioners, solar distillers, biogas installations using solar energy to process livestock waste into biogas and fertilizer,[19-20] thermoelectric generators using

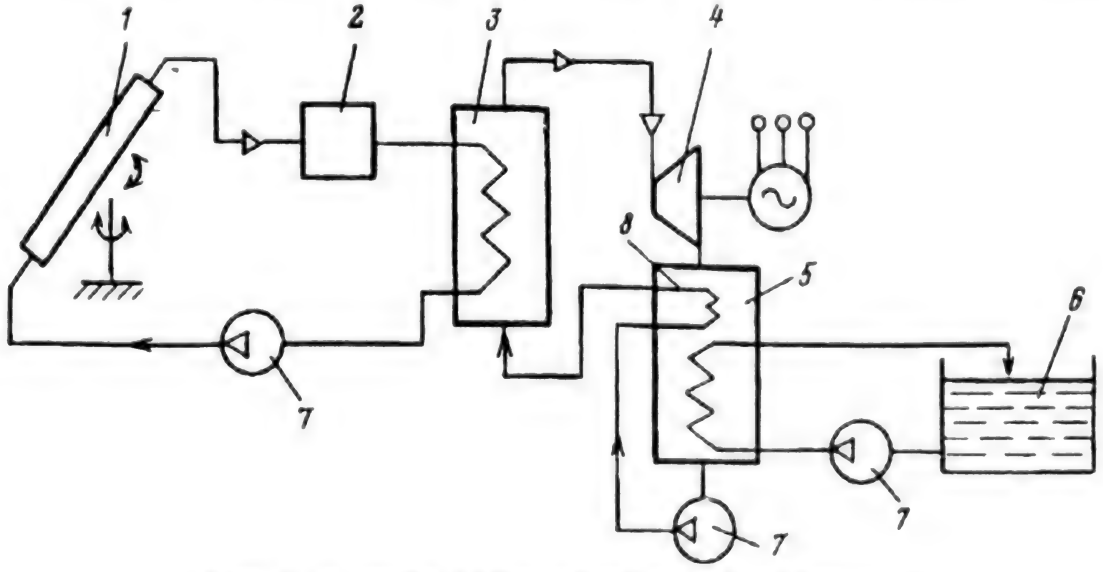

Figure 5. Schematic of 3 kW solar steam turbine energy installation.
Key: 1. Fresnel lens solar energy collector; 2. thermal accumulator; 3 steam generator; 4. turbogenerator; 5. condenser; 6. basin; 7. intake and circulation pumps.

combined sources of heat (the sun and biogas), autonomous energy installations based on various type of conversion of solar energy into electricity and mechanical power. Most of these have passed interdepartmental testing and are recommended for introduction (and have been introduced) at farms, and in existing solar complexes. They are also being used at the experimental bases of Solntse.

At present power is provided to autonomous sheep raising solar complexes with a diesel-wind generator system with a biogas installation. In the future autonomous sheep raising solar complexes and other complexes will be equipped with solar energy installations (Fig. 1).

For the first time in domestic practice a steam turbine energy installation with a power output of 3.0 kW has been produced with concentrating Fresnel lenses (Fig. 5). The results make it possible to predict that it may be practically used for a cost of 3-5 rubles/W.[21]

Research on the creation of pneumatic energy installations used with a solar basin, membrane compressor, turbogenerator, and other components is being studied. There are no similar installations. In addition to producing electricity, it will be an air conditioner. This simultaneously solves the problem of accumulating energy in the form of compressed air. An installation to pump salt water which does not require electricity is being developed using this principle. The schematic and construction have received inventor's certificates.[22,23]

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Development of Solar Energy in Russia

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[Text] It is shown that even today solar energy is a serious alternative to traditional power. Various energy technologies are compared in terms of economics and other parameters. Some general assumptions about the path of development of world civilization are presented.

[Text] The total amount of solar energy reaching the Earth's surface exceeds the energy of all world supplies of oil, gas, coal, uranium, and other energy resources listed below[1,2]:

Coal, oil, gas, t ideal fuel-$11x10^{12}$ Uranium, t ideal fuel-$8x10^{12}$ Solar energy, t ideal fuel/yr-$131x10^{12}$ Wind energy, t ideal fuel/yr-$2x10^{12}$ Hydroenergy, t ideal fuel/yr..$7x10^{12}$ Biomass, t ideal fuel/yr .$0.1x10^{12}$ World energy consumption, t ideal fuel/yr-$0.01x10^{12}$

In Russia solar energy also has the greatest theoretical potential (more than 2000 billion tons of ideal fuel):

Production of energy resources, billion t ideal fuel/yr.1.65 Solar energy, billion t ideal fuel/yr-2000 Wind energy, billion kWhr/yr-1000 Hydroenergy, billion kWhr/yr-852 Energy of small rivers, billion kWhr/yr..150-200 Biomass energy, billion t ideal fuel/yr-20-30 Energy of seas and oceans, billion kWhr/yr ...210 Coal, billion t-300-500 Oil, billion t-20-40 Gas, trillion m^3-20-40

Despite this great potential, in Russia's new energy program the contribution of renewable sources of energy in the year 2000 is very small, 15-19 billion tons of ideal fuel.[3]

The opinion is widely held that practical use of solar energy is a thing of the distant future (after 2020). This paper shows that solar energy is a serious alternative to traditional energy even today.

Before we compare various energy technologies in terms of economics and other parameters, we must define their actual cost, since actual prices in Russia for fuel and energy in the last 70 years have not reflected real expenditures for their production. Only in normal price formation will economic stimuli directed toward saving energy and creating new energy technologies be effective.

This paper uses world prices, although before now the charges for energy have not reflected a significant part of the cost of energy production in any country of the world; this portion was distributed to expenditures for society as a whole.

Each year the world consumes as much oil as was formed in natural conditions in 2 million years.[4] The gigantic demand for nonrenewable energy resources at a relatively low price, which does not reflect the set of real expenditures of society, in essence means a life of borrowing from future generations, who will not have energy accessible at such a low price. This is only one of the component expenditures which society pays for energy which is not reflected in the market price.

Another component cost of energy which is distributed to society as a whole and not included in the charge for energy is associated with environmental pollution by energy facilities.[5,6] It has been established that in one day in the world in 1992[5] 12,000 barrels (1 barrel = 159 liters) of oil poured into the ocean; 60,000 barrels of oil were burned; 413 atomic reactors produced 5% of the energy and yielded 26 tons of radioactive by- products; 70% of the urban population (1.5 billion people) breathed air which was dangerous to their health; 56 million tons of carbon dioxide spewed into the atmosphere; 1500 tons of chlorfluorocarbons destroyed the ozone layer; 140,000 new automobiles joined the 500 million existing vehicles; the US with 5% of the population consumed 25% of the primary energy resources of the world.

The emissions of thermal electric power plants consist mainly of carbon dioxide, which causes the greenhouse effect and a change in climate, which leads to drying of the regions where grain and potatoes are produced. Other emissions contain sulfur and nitrogen oxides, which are converted to sulfuric and nitric acid in the atmosphere and return to Earth as snow or acid rain. The increased acidity of the water leads to a decrease in the productivity of soil, a decrease in the supply of fish, drying of the forests, and damage to structures and buildings. Toxic heavy metals such as cadmium, mercury, and lead may be dissolved in acids and enter drinking water and agricultural products.[7]

There is great uncertainty in the determination of the real cost of electricity obtained from atomic power plants. It can be stated that real prices in atomic energy will be determined after the issues of safety of atomic power plants and nuclear technology to obtain fuel and burial of by- products are resolved, and methods are developed for handling equipment, buildings, and structures of atomic power plants which are taken out of service after 30 years of service. These prices will be higher than existing prices.

Our estimates and foreign estimates of direct social expenditures associated with the harmful effects of electric power plants, including illness and reduction of the life span of people, payment for medical treatment, losses in productivity, reduction of harvests, restoration of forests and repair of buildings due to air, water, and soil pollution are about 75% of the world prices for fuel and energy.[8] In essence, these expenditures by society as a whole are an ecological tax which a citizen pays for the imperfection of power installations. This tax should be included in the cost

of energy to form a state fund for saving energy and creating new ecologically clean technologies in power engineering.

If one considers these currently hidden costs in the charges for energy, most new technologies of renewable energy become competitive with the existing ones. At the same time, there is a source of financing for new projects for ecologically clean power. Just such an "ecological" tax of from 10 to 30% of the cost of oil has been introduced in Switzerland, Finland, the Netherlands, and possibly in 1994 in Germany and the countries of the European Community.[5]

Below we present alternative energy technologies that primarily use renewable sources of energy.

1. Electrophysical methods of obtaining solar grade silicon from naturally pure quartzites.
2. Solar photoelectric plants.
3. Solar-fuel thermal electric power plants with concentrators.
4. Geothermal thermal electric power plants.
5. Pressureless and low-pressure micro and mini hydroelectric power plants.
6. Energy-saving technologies for a solar house:

- active and passive systems with solar collectors;
- transparent heat insulating walls;
- superinsulated windows;
- new materials for heat accumulators with a phase transition;
- super heat exchanger to use the waste heat of air and water;
- heat pumps; autonomous installations for comprehensive supply of energy with a Stirling motor.

7. Wind power generators.
8. Gas, motor fuel and electricity from biomass.
9. Hydrogen energy.
10. Electric and solar automobile transport.
11. One wire energy-saving system for conversion and transmission of electricity.

Geothermal, wind, and hydroelectric power plants are economically competitive at any power output level, which is limited only by the presence of the appropriate energy resources. Geothermal energy, strictly speaking, is not renewable; its methods are traditional and they are not examined in this paper. The potentials of wind and hydroenergy are respectively 0.02 and 0.07% of solar energy and can provide energy to local and regional consumers with a total power output from several hundred to thousands of megawatts.

Energy-saving technologies for a solar house are the most acceptable in terms of economic effectiveness. They can reduce energy consumption in homes to 60% (Tables 1 and 2).[9] An example of the successful use of these technologies can be found in the "2000 Solar Roofs" project in Germany.[10]

Table 1. Thermal loses (kWhr/yr) in a rural home with an area of 120 m^2 at 55-60°N (Ref. 9)

Heat losses	Typical home	Energy-saving home
	Double frame window	Evacuated window, window filled with argon or krypton. Glass with heat reflecting coating
Heat transfer coefficient, $W/(m^2K)$	5.5	2.0
Heat losses through window and ventilation	15,840	5084
	Concrete or brick walls	Transparent heat insulation of walls
Heat losses through enclosure structures	11,530	4952
Total heat losses	27,530	10,036

Table 2. Energy consumption (kWhr/yr) in a rural home with an area of 120 m^2, 55-60°N (Ref. 9)

Factor	Typical home	Energy-saving home
Heating	12,080	0
Supply of hot water	4000	0
Heat pump, using heat of ventilator output	0	3630
Electricity	5870	2400
Solar battery	0	2450
Total	21,950	3580

In the US solar water heaters with a total power output of 1400 MW have been installed in 1.5 million homes.[11] In Germany, a new technology of transparent heat insulation for buildings and solar collectors with a temperature of 90-150°C has been developed.[12]

As world prices are approached, technologies of obtaining gas and motor fuel from biomass become economically acceptable. For example, experience shows that a farmer who has a crop of rape and rape seed oil may be independent of motor fuel supplies. In regions rich in peat and wood with a motor fuel deficit, the technology of gasification, which yields ethanol and methanol makes it possible to use gas and synthetic fuel in diesel electric generators and automobiles. The absence of economically acceptable technologies for accumulation have held back widespread use of hydrogen and electric transport However, intense research is being conducted in this area and it cannot be ruled out that in the near future new solutions will be proposed. This happened in the systems for the conversion and transmission of electricity.[13] In 1992 the All-Union Institute for Agricultural Electrification, together with the All-Union Electrotechnical Institute (author S. V. Avramenko) developed and tested a model of this type of system with an output of 1.5 kW. In 1994 we hope to increase the output to 100 kW. In addition to reducing the number of wires to one, electric power lines will have virtually no Joule losses or corona losses, and the authors estimate that these properties will be maintained when the level of transmitted power rises to 10 GW or more.

Solar power stations may be used to solve local energy problems and global energy problems.[14] For a 12% efficiency of a solar power plant, all current demand for electricity in Russia could be obtained from a solar power plant with a active area of about 4000 km^2 which is 0.024% of the territory.

Hybrid solar-fuel electric power plants with the following parameters have had the most practical world application: steam temperature 371°C, steam pressure 100 bars, efficiency 13.9%, cost of electricity produced 0.08-0.12 US$/kWhr, total output in US 400 MW at a cost of 3 US$/W.

Hybrid solar-fuel electric power plants [1991]

Volume of production ..80 MW/yr Cost of 1 kWhr ..0.08-0.12 US$

Solar photoelectric stations Total output.50 MW/yr Cost of 1 kWhr (without storage)-0.2-0.3 US$

Wind electric power generator Total output ....300 MW/yr Cost of 1 kW..1200-1700 US$ Cost of 1 kWhr..0.05-0.07 US$

A solar-fuel electric power plant operates in peak mode at a cost per 1 kWhr of electricity in the energy system of: from 8AM to 12PM 0.066 US$; from 12PM to 6PM 0.353 US$ (Ref. 15). The efficiency of the solar power plant may be increased to 23%, the average efficiency of system electric power plants, and the cost of electricity can be reduced by combined processing of electricity and heat.

The main technological achievement of this project is the creation by Flachglass Solartechnik GMBH of a technology to produce a glass parabolic-cylindrical concentrator 100 m long with an aperture of 5.76 m with an optical efficiency of 81% and a life time of 30 years.[16] When this mirror technology is present in Russia it will be expedient to mass produce solar energy stations in the southern regions, where there are gas pipelines or small deposits of gas and direct solar radiation exceeds 50% of the total.

Fundamentally new types of solar concentrators which use holography technology have been proposed by the All-Union Institute for Agricultural Electrification. Their main characteristics are the combination of the positive qualities of solar electric power plants with a central receiver and modular design and the possibility of using the receiver as a traditional steam heater or silicon solar elements.

One of the most promising technologies in solar energy is the creation of photoelectric stations with silicon solar elements which convert the energy of direct and scattered components of solar radiation .nto electricity with an efficiency of 12-15%. Laboratory models have an efficiency of 23% (Ref. 17). World production of solar elements exceeds 60 MW per year and increases annually by 30%.

The current level of production of solar elements corresponds to the initial phase of their use for lighting pumping water, telecommunication stations, powering appliances in remote regions and vehicles. The cost of solar elements is 2.5-3 US$/W, modules, 5-6 US$/W and systems 9-10 US$/W with a cost of electricity of 0.25-0.56 US$/kWhr (Table 3).

Table 3. Cost of an autonomous solar energy installation, 0.1 kW, 12 V, 100-120 kWhr/year, in US$

Components of energy installation	Cost
Solar battery 1 m^2, 0.1 kW, 12 V	500
Chemical battery 1 kWhr, 12 V	125
Charge controller	50
Cables and connectors	100
Total:	775
Replacement of chemical battery in 10 years	85
Servicing	65
Total	925
System with 1 W peak power	9.25
Cost of 1 kWhr of electricity	0.56

An autonomous solar energy installation for a rural cottage, store, public building (maximum variant) has the following characteristics:

Cost..18,000 US$ Solar battery..1800 W Electrochemical accumulator..18 kWhr Charge controller, inverter annual production of electricity.1800-3600 kWhr Load, kWhr/yr: lighting.150 television, radio, vacuum.200 refrigerator.90 freezer..180 washing machine..240 microwave oven..400 ventilator...275 dishwasher...310 Cost of electricity...0.56 US$/kWhr Replaces:electric generator using liquid fuel. Advantage: economical, quiet, ecologically clean.

Solar energy installations replace kerosene lamps, candles, dry cells and batteries, and at a significant distance from a

power system and with a small load, diesel electric generators and power transmission lines.[18,19] The cost of electricity for remote consumers is presented below.

Construction of power transmission lines to a power system (1990) Cost of equipment and construction of line.25,000 US$/km Service life of equipment-20 years Length of line .50 km cost of electricity: for a 50 MWhr/yr load .4.8 US$/kWhr for a 300 MWhr/yr load-0.6 US$/kWhr

Liquid fuel electricity generator (1990) Capital expenses.920 US$/kVA Cost of diesel fuel.0.43 US$/kWhr Cost of fuel transportation-5,10^{-5} US$/kWhr Wages and servicing.0.25 US$/kWhr Service life of diesel.100,000 hr Cost of electricity: for a production volume of 50 MWhr/yr and transportation of the fuel 500 km.4 US$/kWhr volume of production of 300 MWhr/year-0.6 US$/kWhr

Solar photoelectric energy installation (1991)

Cost of electricity-0.56 US$/kWhr

In the US there are several experimental photoelectric stations with a power output of form 0.3 to 6.5 MW which work in a power system. The second phase of mass production and use of solar electric power plants in a power system is linked with the creation of technologies and materials which make it possible to reduce the cost of rated power by about a factor of 5, to 1-2 US$/W, and the cost of electricity to 0.10-0.12 US$/kWhr. The principal limit for this reduction in cost is the high price of solar grade silicon, 40-100 US$/kg. Thus, the creation of new technologies for obtaining silicon which provide a radical (by an order of magnitude) reduction in its cost is the number one goal in the list of alternative energy technologies. The situation with solar silicon can be compared with the situation with aluminum after its discovery in 1825 when it cost as much as silver and was used for adornment. Only after the electrolysis technology was developed in 1886 did aluminum become cheap and accessible.

The silicon content of the Earth's crust is 29.5% ($8x10^{18}$ tons) and exceeds the content of aluminum by a factor of 3.35 (Table 4).[20] The Earth contains 15.2% silicon by mass, which corresponds to a fantastic mass of $9.08x10^{20}$ tons (Ref. 21). Solar grade silicon with a purity of 99.99% costs as much as uranium for an atomic energy plant, although silicon content in the Earth's crust exceeds the uranium content by a factor of 100,000.

Table 4. Materials for solar energy

Element	Content by mass in Earth's crust, %	World production t/yr	Cost, US$/kg
Oxygen	47	-	-
Metallurgical silicon	29.5	$0.72x10^{6}$	0.5-2.0
Semiconductor silicon	-	$7x10^{3}$	40- 100
Aluminum	8.8	$2x10^{7}$	1.3
Iron (steel)	4.65	$4.8x10^{6}$	0.25-0.3
Titanium	0.63	$2.5x10^{5}$	4.85
Nickel	$1x10^{-2}$	$9x10^{6}$	7. 3
Copper	$4.7x10^{-3}$	$7x10^{5}$	1.3-2.0
Lead	$1.6x10^{-3}$	$7x10^{6}$	0.3-0.5
Tin	$2.5x10^{-4}$	$1.8x10^{5}$	5 .8-6.0
Quartz	12	-	0.2-2
Uranium	$3x10^{-4}$	$45x10^{3}$	40-60

The world's reliable supplies of uranium are estimated to be 2763 thousand tons.[22] The uranium fuel cycle, including the production of uranium hexafluoride, is substantially more complex and more dangerous than the chlorsilane method of obtaining solar grade silicon. Considering the dispersion and low uranium content of the Earth's crust compared to silicon, it is difficult to understand why uranium fuel for nuclear reactors and silicon for solar use cost the same. There are several reasons for this. Billions were invested in the development of the technology and production of uranium, mainly in military programs, nd the volume of production of uranium is a factor of 6 higher than the production of solar grade silicon (Table 5).

Table 5. Comparative characteristics of energy material for atomic and solar power plants

Characteristic	Uranium	Silicon
Content in Earth's crust by mass, %	$3x10^{-4}$	29.5
World reliable supplies, 1000 t	2763	More than $25x10^{6}$
Annual production, 1000 t	45	Metallurgical 1000, solar 7
Cost, US$/kg	40-60	Metallurgical 0.5-2, solar 40- 100
Energy equivalent for 30 years, MWhr/kg	3000	Amorphous film 3000, crystalline solar 300
Resources at electric power plant, years	30	50-100

The chlorsilane technology of producing solar silicon, developed about 35 year ago, has remained virtually unchanged, and retains all the negative features of chemical technologies of the 1950s: high energy consumption, low yield of silicon, and ecological danger.[23]

The main material for the production of silicon is silica in the form of quartzite or quartz sand, which constitutes 12% of the mass of the lithosphere. The high binding energy of Si-O, 464 kJ/mole means large energy expenditures for reduction of silicon and subsequent chemical cleaning, 250 kWhr/kg, with a silicon yield of 6-10%.

In 1970 the USSR, Germany, Norway and the US studied the creation of technologies to obtain silicon which eliminate the chlorsilane cycle.[24]

In 1984, Siemens (Germany)[25] and in 1985 Elkem (Norway) together with Dow Corning and Exxon (US)[26] announced completion of the development of a technology to obtain solar silicon using carbothermic reduction of especially pure quartzites with a solar element efficiency of 10.8-11.8%. In 1988 Nippon Sheet Glass, and Kawasaki Steel Corp.[27] announced the development of solar technology.

In 1990 the efficiency of solar silicon elements was 14.2% compared with 14.7% for the chlorsilane silicon.[28] The Siemens technology uses especially pure quartzites with a contaminant content of 20×10^{-6} by mass. Our joint investigations with Siemens showed that the quality of Russian quartzites is one of the highest in the world, and there are supplies sufficient to manufacture solar photoelectric plants with an output of more than 1000 GW.

The new technology for producing solar grade silicon by direct reduction from naturally pure quartzites has the following characteristics: electricity consumption 15-30 kWhr/kg; silicon yield 80-85%; cost of silicon 5-15 US$/kg. When this technology is widely used the cost of solar elements and modules will be 0.7-1.4 and 1.0-2.0 US$/kg respectively, and the cost of electricity will be 0.10-0.12 US$/kWhr. In the new technology chemical methods are replaced with ecologically acceptable electrophysical processes.

In Russia at present there are eight enterprises with the technology and production power to manufacture 2 MW solar elements and modules per year.

In 1992, two factories of the Integral Association in Minsk mass produced solar elements using a technology developed in accordance with the program titled "Ecologically Clean Power" at the All-Russian Scientific Research Institute for Electrification of Agriculture of the Russian Agricultural Academy. The production power of these factories makes it possible to annually produce 1-2 MW of solar elements and modules without restructuring the main production line. In the case of specialization of several factories for the production of solar element in Russia, the volume of production by 2000 will exceed 200 MW per year and by 2010, 2000 MW per year. However, this requires state investment support of new energy technologies, primarily the technology of producing solar silicon.

The development of the photoelectric branch of industry requires, in addition to solar silicon, the creation of the production of special hardened glass with a low content of iron, aluminum rolled products, and electronic regulating devices. In Russia, the appropriate production ability exists.

A solar electric power plant working in a power system may not have daily and seasonal accumulation if its output is 10-15% of the output of the power system.[19] For Russia,this corresponds to a 40 GW solar electric power plant, which would require about 400 km^2 of solar elements.[29] The most favorable regions of the Russian Federation for the construction of solar electric power plants to produce 2000 kWhr/yr of electricity per 1 m^2 of solar elements are: Astrakhan oblast, Volgograd oblast, Sochi, Kalmykiya, Dagestan, Tuva, Chitinskaya oblast, Buryatiya, and the Primorskiy Kray. The materials required for solar electric power plants with an output of 1 million kW are shown in Table 6. An algorithm in FORTRAN, the SVET program, has been developed to calculate the production of electricity by a solar electric power plant. The program includes the GIS subroutine developed using the results of Refs. 30 and 31. GIS calculates the histograms of the hourly values of insolation. The TILT subroutine calculates the irradiation of inclined surfaces in different orientations, including those in tracking systems. An anisotropic model of solar radiation scattering is used.

Table 6. Materials to manufacture a 1 million kW solar photoelectric power plant

Materials	Amount, t	Cost, million US$	
		1991	2000
Solar grade silicon	25,000	1500	300
Hardened glass 3 mm thick	10km^2	200	250
Aluminum	2000	2.6	2.6
Iron	10,000	3.0	3.0
copper	400	1.0	1.0
Tin-lead solder	20	0.1	0.1
Other materials	-	5.0	6.0
Total	-	1711.7	562.7

For each hour of use the distribution density is determined for solar radiation power incident on the surface of the solar electric power plant.[32]

For average multi-year monthly totals for radiation the error at a 0.9 probability level with averaging over 30 years does not exceed 8%.[33] For weather stations with a smaller averaging period it may increase by a factor of 1.5-2.

The error in estimating the hourly total radiation incident on a horizontal surface is 5-7%.[34]

By our estimate, which was obtained by direct comparison of experimental data on the incidence of solar radiation on an inclined surface and calculated results for these same surfaces (the SVET program) the error in practically

important cases does not exceed 18%. In the majority of cases the calculation error is from 1 to 8%.

Data from the following weather stations was used in the selection of a location for a solar electric power plant in the territory of Russia: Astrakhan, Sochi, Khuzher (Baykal), Ulan-Ude, Borzya (Chitinskaya oblast), Kamennaya step (Voronezhskaya oblast), Oymyakon (Yakutiya), Khabarovsk, and Nizhniy Novgorod.

Calculation and the experience of using solar electric power plants shows that the hourly production of electricity, which is proportional to the change in solar radiation over the course of the day, to a great extent corresponds to the daily maximum load in the power system (Table 7)[15,35]

Table 7. Average hourly production of electricity (million kWhr) for a solar electric power plant with a peak output of 1 million kW (Khabarovsk weather station)

Solar time, hr	January		June	
	without solar tracking	tracking in two axes	without solar tracking	tracking in two axes
4	-	-	-	0.02
5	-	-	0	0.34
6	-	-	0.06	0.43
7	-	-	0.22	0.53
8	0.07	0.13	0.38	0.62
9	0.38	0.59	0.53	0.69
10	0.57	0.73	0.65	0.74
11	0.70	0.82	0.74	0.76
12	0.75	0.83	0.76	0.78
13	0.70	0.82	0.74	0.76
14	0.57	0.73	0.65	0.74
15	0.38	0.59	0.53	0.69
16	0.07	0.13	0.38	0.62
17	-	-	0.22	0.53
18	-	-	0.06	0.43
19	-	-	-	0.34
20	-	-	-	0.02

The maximum values for the annual production of electricity for a 1 million kW solar electric power plant were obtained for a southern orientation with an angle to the horizon of 45°: for Khabarovsk, 1,846 billion kWhr; Borzya Chitinskaya oblast, 1898 billion KWhr; Ulan-Ude, 1,703 billion kWhr; and for taking in two axes, respectively, 2.51; 2.607; and 2.345 billion kWHr (Table 8). In the European part of Russia the optimal locations for a solar electric power plant are the shores of the Caspian and Black Seas, and Povolzhye. The area of the central solar electric power plant is about a factor of 4 bigger than the active area of solar elements.

Table 8. Production of electricity (million kWhr) for a solar electric power plant with a peak power of 1 million kW

Month	Khabarovsk weather station		Astrakhan weather station		Ulan-Ude weather station	
	without tracking	tracking in two axes	without tracking	tracking in two axes	without tracking	tracking in two axes
I	131	168	60	71	99	130
II	166	216	90	111	137	181
III	198	263	126	159	172	230
IV	174	240	168	231	166	229
V	174	251	179	263	175	254
VI	178	272	193	309	174	262
VII	159	232	169	254	162	236
VIII	150	205	181	256	165	229
IX	151	196	170	223	152	202
X	137	172	126	155	127	164
XI	121	158	82	100	88	113
XII	107	137	51	61	86	115
Total	1846	2510	1595	2193	1703	2345

The specific cost of a solar electric power plant does not depend on its size and power; in a number of cases it is expedient to construct solar electric power plants modularly in the roof of a rural home, cottage, or farm. The owner of a solar power plant may sell electricity to the power system during the day and buy it from the power company using another meter during the night. The advantage of this use, in addition to encouraging small and independent energy producers, is savings on support structure and ground area, as well as combining the functions of a roof and a source of energy.

For modular implementation of a 1 million kW solar electric power plant one can obtain electricity for 500,000 rural homes and cottages.

In conclusion, let us note several main assumptions about the development of world civilization. Economic laws and the history of the development of the world economy shows that an efficient structure for the use of natural resources in a long-term perspective is striving toward the structure of existing resources on Earth.

Since the mass of silicon in the Earth's crust is second only to oxygen, one can assume that from the first people with primitive silicon tools, after thousands of years we have come to a period in which ceramic, glass, silicate and composite materials based on silicon are used for construction. The global source of energy is silicon solar electric power plants, the problems of daily and seasonal accumulation may be resolved with a solar-hydrogen energy system, as well as latitudinal positioning of solar power plants and new energy-saving systems to transmit energy between them. Considering that 1 kg of silicon produces 300 MWhr of electricity over 30 years in a solar element, it is easy to calculate the oil equivalent of silicon. Direct

calculation of the 300 MWhr of electricity considering the heat of burning oil, 43.7 MJ/kg, yields 25 tons of oil per 1 kg of silicon. If one considers the efficiency of thermal electric power plants using fuel oil is 33%, then 1 kg of silicon is equivalent to about 75 tons of oil in the electricity it produces.

With high reliability, the lifespan of the main component of a solar electric power plant, the silicon and solar elements, may be increased to 50-100 years. This requires the elimination of polymer materials from the sealing process. The only limit is the need to replace solar elements with more effective ones. A 25-30% efficiency may be reached in production in the next 10-20 years. When solar elements are replaced, the silicon may be reused, and the number of cycles for its use are not limited over time.

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100 kW Wind Power Generator

947E0125C Moscow TEPLOENERGETIKA in Russian No 2, 1994 pp 61-64

[Article by G. G. Yenikeyev, L. I. Kanatyev, Ufim State Aviation Technical University; UDC 620.9]

[Annotation] A 100 kW wind power generator has been developed. The device in general, the specifications, and the construction of basic elements are examined.

[Text] The Ufim State Aviation Technical University has developed a 100 kW wind power generator. The project was included (on a competitive basis) in the State Scientific and Technical Program "Ecologically Clean Power" in the "Nontraditional Power" section, and has received state support from the Ministry of Science, as well as in the technical policy of the Russia Federation. Customers for this project include the Energobalans wind power association, the Bashkortostan technology park, and other enterprises. The project is being carried out in a special laboratory at the Ufim State Aviation Technical University in collaboration with a number of scientific research institutes of the Zhukovskiy Central Aerohydrodynamic Institute, the All-Union Scientific Research Institute of Electric Power, and others, as well as enterprises in the aerospace industry in Russia.

Two models of the generator were developed for use as part of a power system and in a local electric network with a diesel generator.

The wind generator is a wind wheel 24 m in diameter directed against the flow of the air. The wheel has three blades with a variable graduation, a planetary two-stage step-up gear, a hydraulic low-speed disk brake, a synchronous electric generator with a rotation speed of 1500 rpm, and a hydrosystem of mechanisms to rotate the blades and head.

Russia has a number of settlements where electricity for residents and industry is supplied from dead-end electricity networks or diesel generators of various outputs. In most of these settlements electricity from diesel generators is fed to the local network for several hours a day, which worsens living conditions for the populace.

Geographically, these settlements are in northern regions, where the heating season lasts up to 300 days per year. Most of the boilers use liquid fuel which is transported to the settlement. Fuel delivery is very expensive.

The output of diesel electricity generators in the settlements does not exceed 500 kW. Examples of these electricity generators in Murmansk oblast are presented in Table 1.[1]

Table 1.

Settlements of Murmansk oblast	Rated power, kW	Annual energy production 1000 kWhr	Used rated power, hr/yr
Oktyabrskiy	460	1455	3160
Indel	275	270	980
Krasnoshchelye	180	262	1450
Kuzomen	165	141	855
Munozero	150	141	940
Varzuga	140	147	1050
Moseyevo	55	71	1250
Kanevka	37	60	1620
Ustye Varzgi	30	42	1460
Olenitsa	24	83	3460

The locations of these settlements, especially on the shores of the northern seas, present significant wind potential. As an example, Fig. 1 presents a map of regions of the Kola peninsula showing isolines of average annual wind speed. In many regions the average annual wind speed exceeds 6 m/s (Ref. 1).

Figure 1. Map of wind distribution on the Kola peninsula.
a. Barents Sea; b. White Sea; c. Murmansk

Even more favorable wind conditions can be found on Dixon Island, other territories of the Far North and Far East, Kamchatka, the Sakhalin peninsula, and the islands of the Kuril chain.

In these zones, for example, at an average annual wind speed of 8 m/s, a 100 kW wind generator can produce 350,000 kWhr of electricity.

The project includes the development, and manufacture of an experimental model, as well as testing and preparation for mass production of a wind generator based on a 100 kW wind turbine.

The power produced by wind generators is not stable over time due to the random nature of the wind. Figure 2 (Ref. 2) presents the values of instantaneous power for a wind farm of 23 wind generators, each with a output of up to 200 kW. These numbers illustrate the instability of the power produced.

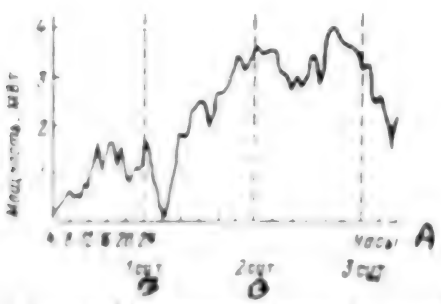

Figure 2. Values of instantaneous power for a wind farm of 23 wind generators

Key: A. [illegible] B. [illegible] C. [illegible] Power, MW

Table 2.

Location	Wind turbine power, kW	Diesel power, kW	Ratio of wind power to diesel power
Calabria	20	2x20	0.5
Cape Clear	2X30	72	0.83
Indian Ocean	30	120	0.25
Montorio Aiv	225	375	0.6
Palma de M	30	2x20	0.75

Analyzing the experience of foreign use of wind generators, the authors have concluded that use of a heat storage device (boiler) in a wind farm substantially increases the profitability of the entire system, expands the range of wind speeds which can be used, and simultaneously acts as a damper load.

[illegible]nerator. The general form of the VEU-100 M [illegible]l model of the wind generator is shown in Fig. 3. [illegible]ination of two designs of wind generator in one is t[illegible]nically and economically inexpedient, and in the final analysis modification is determined by the demands of the customer.

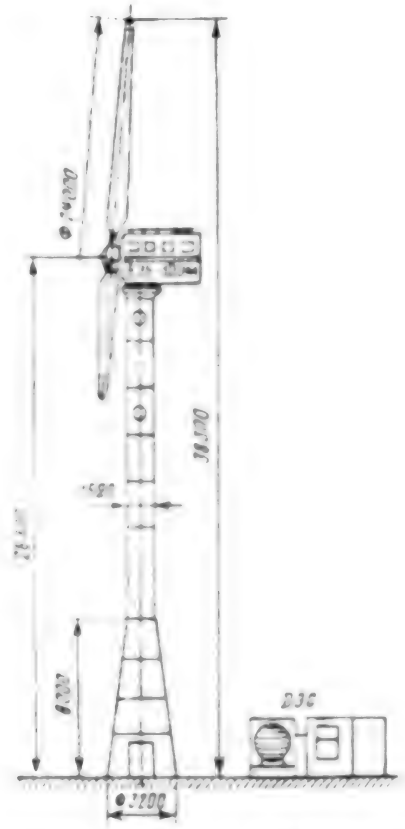

Figure 3. General view of 100 kW wind-diesel generator.

To left, VEU-100 M wind generator; to right, diesel generator.

The use of wind-diesel generators is characteristic for local networks abroad.

Table 2 presents data on several foreign wind-diesel generators as examples.

The wind generator is designed for use in locations with an average annual wind speed of 6 m/s at an altitude of 10 m. The system begins to produce energy at a wind speed of about 4 m/s and provides its rated power output of 100 kW at wind speeds of 10.2 m/s for use in a power system, and at 9.5 m/s for use in a local network. The shut-off wind speed is 25 m/s at the level of the wind wheel hub.

Figure 4 shows the results of calculations of the energy characteristic of the wind-diesel model of the wind generator. The calculations were done at the Zhukovskiy Central Aerohydrodynamic Institute assuming that one obtains the maximum coefficient of wind energy use ξ_{max} before the rotation frequency regulator of the wind wheel beings to operate, that is, before the rated wind speed. This mode may be provided at $n = 52.9$ rpm. Figure 5 presents the energy characteristic of the same wind wheel when it is used in a power system which stabilizes rotations over the entire range of wind turbine power. In this case, to obtain a power characteristic identical with the autonomous mode, the wind wheel should rotate at 36.7 rpm. In terms of design, this means that for the wind-diesel model the gear ratio of the step-up gear is 28.3, and for the system model, 40.87. These gear ratios are implemented in one casing with the same size and connection dimensions.

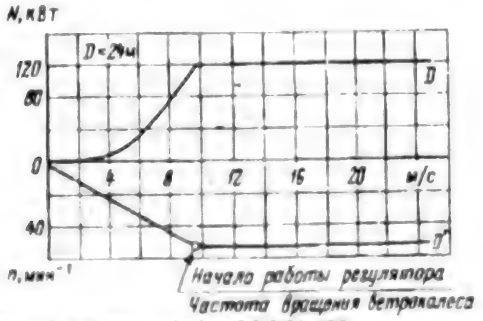

Figure 4. Characteristic of VEU-100, autonomous (wind-diesel) model.

Key: X-axis, wind speed, m/s. Arrow indicates beginning of work of regulator and frequency of rotation of wind wheel. Y-axis, below, n, min⁻¹; above, N, kW

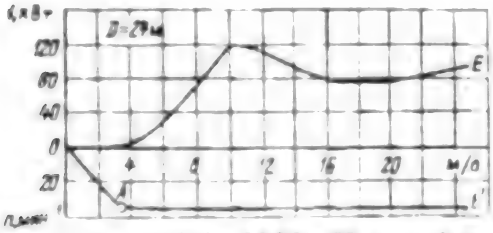

Figure 5. Characteristic of VEU-100, network model.

X-axis, wind speed, m/s. Y-axis below, n, min⁻¹; above, N, kW

Figure 6 shows the speed distribution of possible power production of the wind generator for wind wheel diameters $D = 20$-24-30 m for an average annual wind speed of 6 m/s. Considering what has been indicated above, this distribution is characteristic for the wind-diesel and the system models.

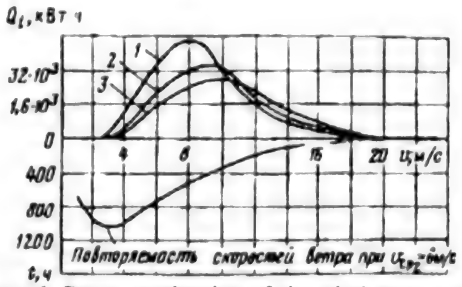

Figure 6. Power production of the wind generator considering the recurrence of winds and various wheel dimensions.

Key: 1. 30 m; 2. 24 m; 3. 20 m. X-axis, wind speed, m/s; Y-axis, below, t, hr, recurrence of wind speeds at an average annual wind speed of 6 m/s; above, Q_t, kWhr

The structural schematics of the supply of electricity with a wind generator are shown in Fig. 7.

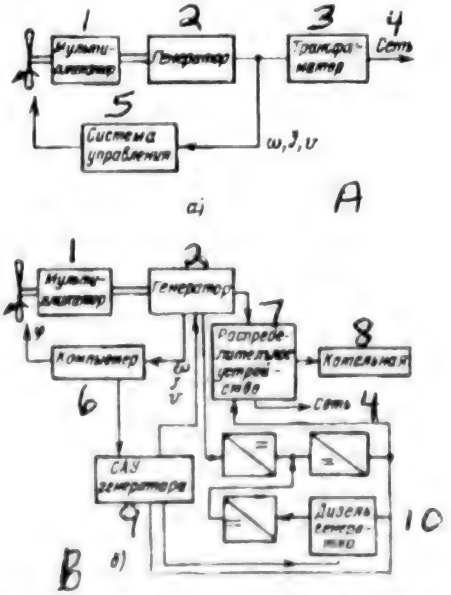

Figure 7. Structural schematics of the supply of electricity to objects. a. network model; b. wind-diesel model.

Key: 1. step-up gear; 2. generator; 3. transformer; 4. network; 5. control system; 6. computer; 7. distribution device; 8. boiler; 9. generator automated control system; 10. diesel generator

In the system model the electrical schematic consists of a synchronous generator, and protection, control, and switching systems.

The wind-diesel model also includes an inverter, distribution device, generator automated control system, a computer and load associated with the infrastructure of the user. The computer monitors, regulates, records parameters, and controls the generator, with the exception of emergency commands. The wind wheel inverter makes it possible to vary speed, and the wind generator mode is optimized in this case by a system which controls activation of the generator and rotation of the blade to change their angle. The boiler makes it possible to dump raw or excess electricity and acts as a load damper in the generator regulation system. The main specifications of the VEU-100 are as follows:

- Rotation rate of generator, rpm
- .1500 Altitude of wind wheel hub, m
- .26.3 Maximum operating wind speed, m/s
- .25 Control of head orientation in wind
- .Electrohydromechanical Control

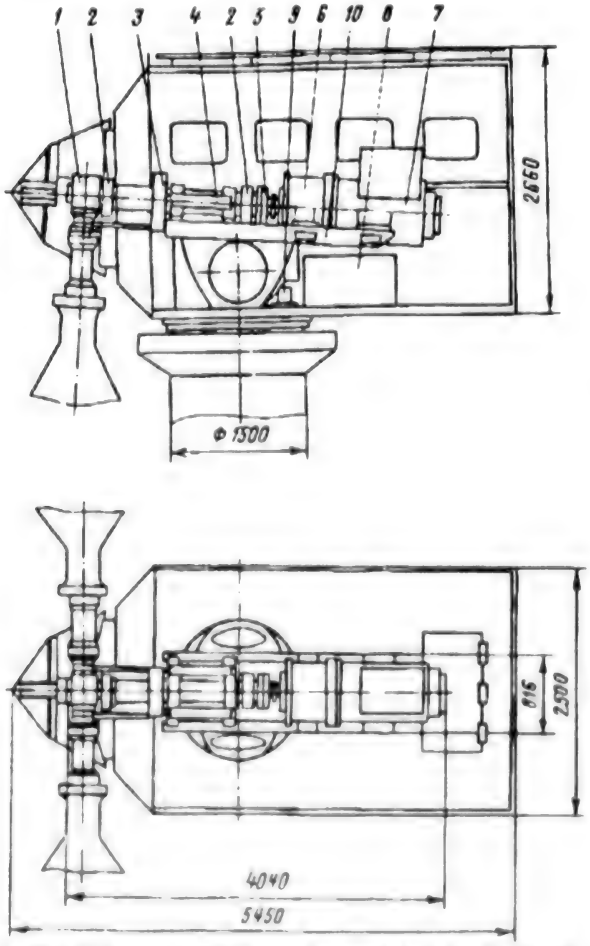

Figure 8. Basic configuration of the head of the VEU-100.

Key: 1. wind wheel; 2. shaft line; 3. support bearing; 4. blade control cylinder; 5. clutch 6. step-up gear; 7. generator; 8. hydrostation 9. wind orientation mechanism; 10. frame.

- .Programmable controller

The configuration of the VEU-100 head is shown in Fig. 8.

Construction of main components

The basic wind generator consists of a wind wheel, a gear with a blade control mechanism, a step-up gear, a generator, a rotating platform with a motor gondola, a tower, and a control system.

The wind wheel has three rotating blades mounted on bearing supports on the hub. The rotating blades are necessary to regulate the rotation speed of the wind wheel in autonomous mode, and are used for automatic braking and stopping on a command from the control system. The aerodynamics of the wind wheel reduce overloads from wind gusts. The blade length is 10.93 m, and the torsion angle from the hub to the periphery is 13°. The Espero profile is used. The projected weight of the blade is 470 kg. The blade material is fiberglass with a foam plastic filling.

The gear with the blade control mechanism consists of a low-speed shaft, bearing supports with a double row of radially-spherical bearings, a variable rigidity clutch to connect it to the step-up gear, and a blade control mechanism. The hydromechanical blade control mechanism makes it possible to set the blades to a specific angle on command from the automatic control system. The blades may be rotated from 0 to 90°. The hub of the wind wheel is attached with a splined joint on the end of the low-speed shaft.

The step-up gear is a planetary mechanism consisting of two geometrically similar planetary gears connected in series to match the rotation speeds of the wind wheel and generator. There is a hydraulic disk brake on the low-speed step-up gear shaft. The step-up gear has a by-pass clutch to cut off the wind wheel from the generator when it is in condenser mode.

The wind generator has a synchronous brushless generator with a rating of 100 kW, 400 V, 50 Hz current, and rotor shaft rotation rate of 1500 rpm.

The rotating platform with gondola is mounted on a bearing with an external diameter of 1650 mm and attached to the tower with bolts. The internal ring of bearings is a gear wheel with an internal gear train. The platform is rotated by a hydromechanical or electromechanical reducer motor. The rotation system has a hydraulic disk brake which protects the platform from unnecessary random yaw motions due to wind loads and is also used to damp the yaw motion. The control system uses a wind sensor to determine wind direction. The yaw motion control system uses half-minute averaging to determine wind direction.

The gondola contains the gear with the blade control mechanism, the step-up gear, generator and auxiliary equipment, hydrosystem, reducer motor of the wind orientation drive, and electronic units for the control system.

The tower is made of steel and consists of three welded sections with a sheet thickness of 8 mm.

The lower section is a truncated cone with a base diameter of 3200 mm. At the base there are flanges to connect the

power with pins to a reinforced concrete foundation. The middle and upper sections are cylinders 1500 mm in diameter. The rotating platform is attached to the upper section with flanges. The sections are bolted to each other. Inside the tower is an enclosed ladder for maintenance personnel to ascend to the motor gondola.

The automatic control system is used to start and stabilize the operation of the generator, to stop it, and to prevent accidents. The system includes an electronic control system, hydrostation, hydrosystem, and executive mechanisms. Each model of the wind generator has its own control algorithm and its own hardware.

At present there is working design documentation for the main components of the system. The hub of the wind wheel, the shaft line, the mechanisms to control the blades with the hydrostation, the frame, cabin, and support device have ben manufactured. The step-up gear is being constructed, and preparations for manufacturing the blades are underway. The components for the wind-diesel version based on the VEU-100 have been selected. The developers and producers of the subsystems have been selected. Once agreement has been reached with the Ministry of Fuel and Energy of Russia on financing of the wind-diesel generator, it will be 18 months before the VDES-100 goes into operation.

The comprehensive development of projects has been held back by insufficient funding due to the absence of legislation to stimulate investors, producers, and buyers of wind generators. There is no legislation requiring state or large commercial electricity networks to buy electricity from the owners of wind generators under advantageous terms. For example, the US has a federal progressive tax which allows investor to obtain a 15% tax credit for investments in wind energy construction. These advantages have stimulated local community utilities to sign long-term contracts with wind power producers.

Enacting legislation in Russia to stimulate the producers of wind technology and users of this technology would improve the situation for the use of ecologically clean sources of energy.

Analysis of foreign experience in developing wind power, domestic developments, and our own experience in developing and manufacturing the VEU-100, as well as analysis of the possibility of concerting Russian enterprises make it possible to conclude that it is necessary and promising to develop large-scale projects to develop and organize mass production of wind power generators in the middle output range up to 100 kW capacity manufacturing.

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New Autonomous Wind Generators from Veten

947E0125D Moscow TEPLOENERGETIKA in Russian No 2, 1994 pp 66-70

[Article by S. A. Nikonov, H. V. Sviridov, Veten Scientific Production firm, Energobalans Association; UDC 621.548]

[Annotation] Specifications and design features are presented for new 4, 8, and 30 kW wind generators developed by the Veten scientific production firm. The initial concepts for generator creation are explained.

[Text] Under the current conditions of establishing a market economy in Russia and the CIS nations, the increase in prices for energy sources has recently significantly increased the demand for relatively inexpensive, simple to use, easily portable autonomous wind generators and low and intermediate power wind generator installations. The increase in the number of small and medium agricultural businesses, the transfer of land to private citizens, the development of the construction of low-rise dwellings, and electrification have had a favorable impact increasing the interest of consumers in autonomous wind power generators.

The restructuring of industry, the incomplete use of production facilities, the need for the former military-industrial complex to produce new types of products and the readiness of the technological base of most machine-building and electrotechnical enterprises to produce wind power equipment explains the desire of many enterprises to master this type of production.

Some enterprises with strong scientific design teams have tried to independently develop wind generators and installations. Unfortunately, due to insufficient practical experience and information, most of these products are at a low level and are unsuccessful, after this enterprises usually lose interest in wind energy work.

It should be noted that the creation of reliable, competitive and effective wind generators and wind power installations is extremely complex and is impossible without using accumulated domestic and world experience. The Veten scientific production firm, one of the main organizations of the Energobalans-SOVENA Association, was founded in 1988 by leading specialists in wind technology who worked previously at the Istra branch of the Vetroen Scientific Production Association (now the Tornado joint-stock company). The firm specializes in the development and production of wind generators and wind power installations of low and moderate power output. Its [illegible] specialists have many years of experience in wind-power development, testing, delivery for production and use of wind generators and wind power installations of various types. Work on such products has been [illegible] for a number of

years at the Vetroen Scientific Production Association and the Veten Scientific Production Firm.

Examples of completed projects carried out under the direction of, or with the direct participation of firm specialists are the AVEU6-4S (1989), the AVE-0.14 (1988), the AVE-0.25 (1990) the UVE-0.1 chargeable wind installations (1988), the Veten-0.1 (1990), the Veten-0.16 (1992), the Azimut wind-gasoline-electric system (1989), the Malyutka wind-electric water pumping installation (1989), the UVEV-6 (1989), the AVMV 1.2 Romashka wind mechanical water pumping installation (1987), the UVM-2 (1988) and other autonomous wind power equipment. The firms' specialists have also participated in the development of domestic wind installations with a power output of 100-250 kW which are produced by the Yuzhnoye Scientific production Association and the Energobalans-SOVENA Association.

Based on the experience accumulated at the Veten Scientific Production firm, a rather stable approach to the development and design of autonomous wind power generators and small and intermediate power output installations (to 30 kW) has been taken. Working on orders from large industrial enterprises, the firm uses scientific design projects from previous years to reduce costs for development and to reduce the time before mass production can be implemented. The main goal is to create wind power generators and installations which are simple and inexpensive to produce and use and which are as good as the best foreign models.

In the development of autonomous wind station designs the firm has tried to adhere to the following recommendations:

1. [illegible] maximum use of pretested and implemented [illegible] and maximize the use of components and [illegible] requiring prolonged experimental verification and testing. For wind generators in the 4-30 kw [illegible] include the "classical" horizontal [illegible] with a two- to three-blade regulated [illegible] rotating blades, and the use of a [illegible] direct effect rotation [illegible] wind wheel. For autonomous [illegible] in small-intermediate power output [illegible] the wind wheel and head of the [illegible] direction of the wind with a wind [illegible]. Attention should be [illegible] mechanisms of the wind wheel [illegible] protection mechanisms. Of all [illegible] the pendulum-motor mechanisms which [illegible] rotating wind wheel by rotating [illegible] has worked well in [illegible] devices on the shaft of the [illegible] supports, preferably [illegible] four steel cable [illegible] the supports should be no less [illegible] the wind wheel.

2. [illegible] comprehensive engineering calculations [illegible] all basic components, parts, and [illegible] wind generator and mathematical model- [illegible] from operation must be done for [illegible] combinations of factors. Attention should be focused on calculations of dynamic and oscillatory processes in transition modes and modes where the wind wheel is at an angle to the wind. The methods of calculating the dynamics of the wind generator developed by the specialists at the firm make it possible to provide a reliable estimate of its behavior even in early stages of development.

3. Construction of the wind generator should be simple and technological in small-scale and intermediate-scale production (200-500 units per year). The production of wind generators should be accessible to average machine building enterprises at relatively small costs (investments) within the factory. It is desirable to use the most accessible and inexpensive materials, components, and technological processes, even if this reduces the weight and size of the wind generator. The cost of placing a 4-30 kW wind generator on the CIS market should not exceed 300-500 US dollars for 1 kW of rated power (calculated from the rate of exchange). The virtually complete absence of western wind generator firms in the CIS market is due to their extremely high cost for domestic users. 200-3000 US dollars for 1 kW of rated power.

4. The construction of wind generators should make them useable for individuals without special training. Minor and intermediate repairs to wind generators, in the absence of a service and maintenance network, are likely to be done by the consumer in primitive conditions. Thus, construction of the wind generator should be simple and understandable, without complex hydraulic, electromechanical, and electronic devices, and with a minimum number of regulators. Assembly and disassembly of wind generators should be possible with generally accessible facilities. It should be possible to lift and lower the wind generator with the manual winch included in the set of spare parts, using an automobile or tractor. Attention should be focused on the safety of service personnel in using and repairing the wind generator. A wind wheel braking mechanism is mandatory.

5. Wind generators should have a rated wind speed of no greater than 9 m/s, with a minimal working wind speed no greater than 50% of the rated speed. At a wind speed of over 25 m/s the wind wheel should automatically stop and should begin work again when there is a steady decrease in wind speed to 15-18 m/s. In general wind generators should be designed for a maximum wind speed of 60 m/s, and should work reliably at temperatures from -50 to +50°C with the possibility of ice glazing, dust and snow storms.

6. The electrical equipment of autonomous wind generators with an output from 4 to 30 kW should work with various loads. The most expedient would be to use mass-produced synchronous and asynchronous three-phase current generators with a voltage regulator which can be varied in the general case according to the law U/f^{n} = const (f is the current frequency). The wind generator must have devices which prevent twisting of the cable inside the tower when the head is rotating (a current controller or a device to automatically untwist the cable).

7. Wind generators should work in automatic mode without using external sources of energy. The period between servicing (examination) should be no less than six months. The automatic control system for a wind generator with a power output of less than 30 kW should be simple and limit the rotation of the wind wheel. It should also stop the wind wheel in storm wind conditions and subsequently put it back into operation. Wind generators with an output of 30 kW or higher should be equipped with an automatic control, diagnostic, and monitoring system to monitor all basic parameters of the generator and stop it when even one parameter leaves the acceptable range of values. These monitored parameters primarily are: rotation speed of wind wheel, current frequency, voltage power, wind speed and vibrations. The diagnostic and monitoring system should store information about wind generator faults until they are eliminated and prevent the device from being started until the fault is corrected.

These recommendations are not exhaustive and provide only a general idea about the principles of construction of wind generators.

At present, Veten is developing wind-electric autonomous generators in the VTN series based on its awarded place in the All-Union Competition for concepts for 8 kW output installations (1989) and its place in the State scientific and Technical Program of Russia, "Ecologically Clean Power." The VTN series of wind generators is intended to serve a wide range of consumers and may be used for heating, charging, and water pumping wind generators, in wind-gasoline electric systems and wind-diesel systems and complexes, in cathode protection systems, as well as independently to supply electricity to autonomous facilities far from electricity networks.

The VTN8-4 wind generator was designed for use in low-wind regions with an average annual wind speed of 3.5 m/s or more. The generator has two blades made of wood and plastic. The blades are completely rotatable and the angle of inclination of the axis of the wind wheel to the horizon is 5 degrees. The blade profile is an Espero profile at the hub and a P-1 profile at the end. The working angle is 6 [illegible] and the position of the blades is [illegible] with a torsion angle of 1[illegible]. The wind generator starts up at the working angles. The rotation frequency regulator of the wind wheel is a mechanical centrifugal aerodynamic direct effect mechanism. Blades are rotated by increasing the attack angle (counter-weather vane type). The regulator spring is a [illegible] located inside the head shaft. The step-up gear is a [illegible] cylindrical external gear with a total gear ratio of 1:[illegible]. The generator is a SGV 4-[illegible] synchronous generator which is coaxial with the wind wheel. The activation and regulation unit is to the side of the head casing. The wind rose reducer is a two-stage worm gear with regulation of the gap in the slow-moving stage. The total gear ratio is [illegible]. The wind wheel is positioned with the direction of the wind in front of the tower using one six-blade wind rose 0.9 m in diameter. The wind wheel is stopped by activating a braking friction clutch mounted on the wind wheel shaft. Activation (release) of the braking clutch may be done automatically or manually from the storm vane. The tower, which is 12 m tall, consists of three tubular sections 219 mm in diameter attached with flanged bolt connections. Inside the upper part of the tower shaft is four-contact ring-shaped current controller. Energy from the generator is fed through the current controller to a cable inside the tower. An automatic shut-off and handle to manually control the braking clutch are in the lower part of the tower. Four tower bracing wires are connected to the ground with metal anchors which are buried 1.2 m in the ground. There is a grounding circuit around the tower. The generator can be raised and lowered by one person or two with a manual levered winch and raising boom which are included in the set of spare parts. The bracing wires are stretched with turnbuckles. The tension of the bracing wires need not be monitored during use. The VTN8-4 can be transported by any type of vehicle. The unit comes in two transport cases. The largest dimension is 4 m. At present the documentation for the generator has been acquired by the forge-pressing automated machine factory (in Odessa oblast) which is manufacturing the experimental models.

The VTN8-8 is intended for use in regions with an average annual wind speed of no less than 5 m/s. The wind generator has two blades made of wood and plastic. The blades can be completely rotated and the angle of the axis of the wind wheel to the horizon is 5 degrees. The blade has a NASA 44 profile, without torsion, and the working angle is 3 degrees. The wind wheel is activated from the working angles. The rotation frequency regulator of the wind wheel is a mechanical centrifugal-aerodynamic direct effect regulator. The blades are rotated toward the direction of lower attack angles (weather vane type). The regulator spring is a screw regulator with a hydraulic vibration damper. The step-up gear is a single-stage, cylindrical, helical step-up gear with an external gear train and a gear ratio of 1:[illegible]. The generator is asynchronous and is based on the mass-produced AIR132S4U2 electric motor with condenser activation and capacitive compounding, which regulates voltage. The activation and regulation unit is near the base of the tower. To stop the wind wheel, it is positioned with the wind in front of the tower with two wind roses [illegible] m in diameter. The wind rose reducer is a two-stage system with gap regulation in slow-moving stage. The slow-moving stage of the wind rose reducer has straight teeth and an external gear train. The fast stage uses a worm gear. The total gear ratio of the reducer is [illegible]. The wind wheel is stopped aerodynamically by rotating the blades into a weather vane position. In stopping, the blades are rotated by a drive from the wheel shaft through a [illegible] from the storm vane or manually with a handle at the lower part of the tower. The tower of the VTN8-8 is compatible with the tower of the VTN8-4. The mounting, transportation, and packaging of both models are the same. There are plans to manufacture experimental models at the [illegible] factory in R[illegible]; work will begin this year.

The VTN16-30 wind generator is a [illegible] development of the Veten scientific production [illegible]. It has been partially financed by Energobalans, an association for the development of wind power. The VTN16-30 is intended for use in regions with an average annual wind speed of no less than 5 m/s. The wind generator has two

blades made of wood and plastic. The blades can be completely rotated, and the angle of the wind wheel to the horizon is 5 degrees.

The hub of the wind wheel is attached to the shaft with a pivoting joint, and the pivot angle is 3 degrees. The rotation speed regulator is a mechanical, centrifugal-aerodynamic direct effect weather vane type regulator. The regulator has two coaxial helical springs and a hydraulic vibration damper. The step-up gear is a two-stage helical cylindrical step-up gear with a external gear train, and is standardized with the step-up gear of the HSW-30 German wind generator. The total gear ratio of the step-up gear is 1:16.32. The generator is a BG-30-4U2 synchronous generator connected to the step-up gear with a elastic compensating protective clutch. The wind wheel is positioned with the wind in front of the tower with a wind rose gear. The wind rose gear consists of a wind rose reducer and a standard rotating crane support with an internal gear train, to which the head of the wind generator is attached The total gear ratio of the wind rose gear is 2262. The drive of the wind rose reducer is two wind roses 1.2 m in diameter or a DC electric motor. The wind rose drive can be automatically shut down. The electric motor is intended for automatic untwisting of the cable and rotation of the head when the wind generator is serviced. Automatic untwisting occurs in low winds and when the cable is twisted more than ¾ of a rotation. The wind rose reducer also has a built-in head rotation counter and a frictional damper for torsional head oscillations. The wind wheel is braked aerodynamically by rotating the blades into a weather vane position. The blades are rotated with a drive from the wind wheel shaft though a screw-nut gear which is activated by the cam clutch, which is controlled by an electromagnet. When the head of the wind generator is serviced, the wind wheel can be stopped manually by blocking the protective clutch on the high-speed shaft of the step-up gear. The subunits of the head are mounted on a welded frame and covered with a removable cover. A suspended balcony is attached to the frame for servicing. The tower of the VIN16-30 wind generator is a three-section tubular tower 0.4 m in diameter with one tier of four steel guy wires. The height to the axis of rotation of the wind wheel is 21.5 m. The tower is equipped with a lifting boom 1 m long. Raising and lowering is done with a manual winch and block and tackle, which are in the set of spare parts. Inside the tower is a ladder which emerges on the balcony of the generator head.

The control and monitoring system of the wind generator consists of a control unit and a battery unit near the base of the tower, as well as sensors for wind speed, wind wheel rotation speed, and vibrations, as well as a head rotation counter and electromagnet on the head of the wind generator to start and stop the wind wheel. The control and monitoring system is supplied with 24 V power from two 6ST-132 batteries in the battery unit. The batteries are charged by the wind generator through a changing device in the control unit.

The control and monitoring unit uses digital microcircuits and monitors the following parameters: average, current, and instantaneous wind speed, rotation frequency of the wind wheel, voltage, frequency and current of generator, vibrations along and transverse to the axis of the wind wheel, the number of head rotations, and the voltage on the battery. If even one of monitored parameters has a value outside the acceptable range, or if there is an unacceptable combination of values of several parameters, the command is issued to stop the wind wheel. The reason for the emergency stop is recorded by an indicator relay. The wind generator is started when power is suppled to the stop-start electromagnet and is stopped when power is shut off. The wind generator is started automatically when the average wind speed exceeds 4 m/s. When an instantaneous wind speed of 25 m/s is reached the wind generator shuts down, and is automatically restarted when a stable average wind speed of 18-20 m/s is reached. The wind generator can also be manually controlled.

The wind generator is serviced twice a year by one person, and the wind generator need not be lowered from the tower. For convenience of servicing and repair, the head has a manual winch with a lifting capacity of 100 kg.

The VIN16-30 can be transported by any type of vehicle. It is packed in two cases, and the largest dimension of the case is [illegible]. Mounting the wind generator requires a crane truck with a lifting capacity of 3 tons with a boom up to 6 m long. The wind generator can be mounted on a precast reinforced concrete foundation by 2 or 3 persons.

The [illegible] VIN wind generator [illegible]

Specification	VIN8-4	VIN8-8	VIN16-30
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Specification (Continued)	VTN8-4	VTN8-8	VTN16-30
Rated annual production MWhr/yr with an average annual wind speed (m/s):			
3	4.1	3.3	17.4
4	8.8	9.9	42.5
5	13.7	18.3	73.3
6	17.8	26.5	103.5
7	21.1	33.7	129.8
8	23.5	39.8	151.4
9	25.344.4	168.5	

Energy-Biological Complexes Using the Waste Heat of Thermal and Atomic Electric Power Plants

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[Article by V. G. Farberov, V. A. Kissin, Atomenergoproyekt; UDC 577.3]

[Text] Discharged heated water from enterprises has been used to produce agricultural products for a long time in Russia and abroad. For almost 30 years the problems of heat-using technologies in horticulture, fish farming, and animal husbandry have been studied (Germany, France, US), primarily biotechnical parameters, heat provision schemes, and the economics of production.

In Russia the present conditions are such that the problem of heat use should be solved at different technical and technological levels than was the case earlier. The low level of power supply to agriculture, high prices for energy resources, the unsatisfactory state of the environment, and the high consumer demand for food products, as well as the large volume of unused waste heat from thermal and atomic electric power plants, force us to examine the problem comprehensively as a social problem of providing basic food products to the populace near thermal and atomic electric power plants while simultaneously reducing environmental heat pollution. We must also examine the technical and economic problem of saving energy and resources while meeting the needs of agriculture in a market economy and developing agricultural production in unfavorable climatic conditions.

This paper presents the main results of many years of research conducted at the energy-biological complex at the Kursk atomic power plant (hereafter EBC KAPP) to test and create new hydrothermal theory and equipment for heat using units. The results of these studies are used in the projects of other EBCs, making it possible to obtain generalized recommendations for heat using agricultural production. The work was carried out in the framework of the State Scientific and Technical Program of Russia "Ecologically Clean Energy."

Description of EBC KAPP

At present the EBC at KAPP includes the following heat-using units: a fish farming unit, a hothouse unit, open heated ground, biological deionization, and utilization of organic wastes.

The fish farming unit implements the following forms of fish farming use of waste heat: tank farming, pond farming, and the use of the cooling reservoir of the Kursk atomic power plant as a pasturing reservoir for the fish. The productivity of the tank farming unit (a live fish factory with a multicycle technology for breeding commercial fish) provides 1000 tons of live carp, as well as the plant material for the carp, and herbivorous fish for stocking ponds and reservoirs. Pond farming is calculated to yield 670 tons of commercial fish (560 tons of carp, 110 tons of trout and sturgeon varieties), as well as valuable collection varieties of fish. The production level reaches 250 kg/m^2 when ponds in the reservoir-cooler are stocked.

Heat is supplied to the tanks by waste heated water taken from the discharge channel of the atomic power plant. When a multiple cycle technique is used to raise carp, in the winter months of cold years the necessary water temperature is maintained using 23,000 GJ/year of commercial heat in the form of supply-line water or steam. The annual consumption of electricity is 5x10^6 kWhr. In pond farming the total annual consumption of electricity does not exceed 0.2x10 kWhr [no exponent appears in source text].

The main problems examined in the fish farming studies were the effect of the water conditioning parameters (hydrothermal and hydrochemical), the assortment of commercial products, and the feeding technology on the cost price of the product, as well as the development of recommendations for structures and equipment for fish farming to reduce power consumption and labor.

The hothouse unit includes 12 hectares of winter "Holland" type hothouses. In 1992 from February to November two agrotechnical cycles produced 1408 tons of cucumbers, 473 tons of tomatoes, 14 tons of lettuce, 24 tons of green onions, and 700,000 flowers. In the first cycle, cucumbers, tomatoes, lettuce, green onions, and flowers occupied, respectively, 7.85, 2.5, 1.0, 0.05, and 0.45 hectares of the hothouse; in the second cycle, the figures were 2.5, 7.85, 1.0, 0.05, and 0.45 hectares. For the climatic conditions of Kursk and the rotations of vegetables, the hothouse heating system was set to maintain a temperature inside the hothouse of +15°C with an extreme external air temperature of -30°C. During the cold part of the year the hothouse was heated by supply-line water (commercial heat) with a temperature of 115/90°C. The heating system consists of a smooth bore heat exchangers above the surface of the ground in a corridor between rows of vegetables. Systems of subsoil heating and watering

were provided which use waste heated water. The annual consumption of commercial heat in 1992 was 289,000 GJ.

The main consumer of electricity in the hothouse unit is the nursery section (0.72 hectares) which is equipped with a system to illuminate the seedlings with 160-200 W/m^2 with a total power use of 1200-1400 kW. Illumination should continue for 12-16 hours per day for 20-30 days for cucumbers and 35-50 days for tomatoes. The total annual consumption of electricity in 1992 was 1.7x10^6 kWhr.

The main goals in hothouse studies were determining the possibility of increasing the yield and quality of the harvest by introducing new agricultural and biological technologies, reducing the cost price of the product while reducing power consumption and labor, developing recommendations for new constructions and equipment for the hothouse to use the maximum amount of waste heat, and selecting the optimal assortment of commercial products and rotations for vegetables.

The open heated ground unit includes 0.9 hectares of heated and 1.1 hectares of control unheated area. The heated area includes delivery and discharge channels, pumping stations, a network of heating and watering pipes in the ground and water regulating equipment.

The polyethylene heating pipes are 500 m long and are placed 0.6-1.2 m apart in the ground at a depth of 0.4-0.7 m. The perforated watering pipes have dimensions similar to the heating pipes and are placed 1.0-5.0 m apart at a depth of 0.4-0.6 m. The consumption of heated waste water for heating does not exceed 10 l/s. The specific heat delivery to the ground depends on the water temperature, meteorological conditions, and condition of the ground, but does not exceed 50 W/m^2.

In the heated ground section one can have two or even three cycles of cultivation; for example, in 1991 the first crop rotation consisted of cabbage, cucumbers, and radishes; the second rotation consisted tomatoes, cucumbers, and radishes.

The open heated ground unit has developed new technologies and designs of heating and watering systems which enable one to reduce the cost price of the product and to select the optimal assortment of commercial products.

The biological melioration unit has the goal of developing technologies for the directed formation of water ecosystems of cooling reservoirs, including: formation of a natural food base for the introduction of highly productive and heat resistant forms of filtering hydrobionts (zooplankton, mollusks, etc.) to reduce the level of development of primary products (phytoplankton and bacterioplankton); formation of ichthyofauna by continuous stocking of filtering fish (white mullet, etc.) to suppress the development of phytoplankton and to eliminate organic matter from the reservoir; creation of various types of bioplateaus from the water vegetation of agriculture.

The organic waste use unit provides wasteless production for the entire EBC. In the first stage of development of this unit, equipment was developed to process organic waste from animal husbandry (a pig farm with 1000 pigs) and fish farming (up to 3 m^3/day). The equipment consists of a preparation unit and an anaerobic fermentation unit with a 150 m^3 reactor. This equipment makes it possible, through comprehensive use of manure and other organic wastes, to obtain high-quality organic fertilizers and fuel gas, methane, by methanol fermentation in the reactor (methane tank) without air at a temperature of 30-35 or 50-55°C. The methane is the initial product to obtain feed additives for fish or livestock. The biological mass which is discharged is stabilized fertilizer for the hothouse and open ground units.

Evaluation of the waste heat of the KAPP

A total of 3180 GJ/hr of waste heat leaves the four operating units of KAPP and enters a cooling reservoir with a circular area of 21.5 km^2. Heated water for the hothouse is collected from the discharge channel of the atomic plant with a maximum water temperature. The table presents the intervals for possible variations in the average daily values of these temperatures for a year with 50% probability of meteorological factors.

Temperature	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
[illegible]	[illegible]	17.4	17.4	19.4	26.0	29.6	33.5	31.6	26.0	23.1	22.8	19.4
[illegible]	[illegible]	25.4	25.4	30.4	33.2	36.0	39.1	35.6	34.0	30.3	28.4	27.4

In exceptionally "cold" years when the air temperature dips below [illegible]°C the average daily water temperatures may [illegible]

To evaluate the potential of using waste heat we present the values of the required medium temperatures for basic technologies of horticulture and fish farming.

Cucumbers grow and ripen at a night temperature of [illegible]°C and a daytime temperature of 25-30°C. The critical temperature (after five nights) is 12°C. The corresponding temperature parameters for tomatoes are 14, [illegible]°C, for lettuce, 4, 12-16 and 2°C.

Acceptable water temperatures for carp are: spawn, 16-23°C; [illegible] 25-34°C; fry, 25-34°C; commercial fish, 23-34°C, breeders, 22-28°C. The threshold of depression is, respectively, 15, 13, 23, 23, and 22°C. Acceptable water temperatures for trout are: spawn 5-14°C, fry 5-19°C, commercial fish 7-18°C. The threshold of depression is, respectively, 3.3 and 5°C. The temperature norm for raising sturgeon is 15-25°C with a depression threshold of 10°C.

It follows from the presented data that for the technologies for growing vegetables in the hothouse, early products cannot be obtained without using commercial heat to heat the hothouse, even in a year with a 50% probability level of meteorological conditions. The reason for this lies in the construction and equipment of winter hothouses, which have large heat losses and an incomplete heating system. To reduce the amount of commercial heat in the total heat

consumption, one must find a way to reduce heat losses and improve the heating system or change the growing cycle and assortment of commercial products.

A complete fish farm cannot avoid using commercial heat to raise carp in winter months. However, some changes in the cycle, i.e., increasing the production of trout and sturgeon in winter months, may sharply reduce the consumption of commercial heat.

Summary of the results of the effectiveness study of EBS KAPP operation

Despite the fact that the hothouse unit was created on the basis of standard designs, new technologies tested and introduced in the course of operation have had a number of positive effects associated with the use of waste heat.

Fish farming unit The structure of the cost price of the products of the fish farm (commercial carp) in 1992 has the following parameters: feed 83%, wages and working expenses 14%, electricity and heat (commercial heat) 3%. Consequently, the main method of reducing the cost price of the commercial product should be based on reducing the consumption of feed while maintaining the commercial volume. Studies have shown that carp can be effectively raised on artificial feeds with a water temperature no lower than 23°C; a change in temperature of 3°C leads to a change (a factor of two) in the use of feed.[1] Thus, maintaining the temperature at a near optimal level helps to save on feed and reduce the cost price.

The temperature of water entering the live fish farm is mainly determined, all other factors being equal, by the amount of low-potential heat discharged into the cooling reservoir. Commercial heat is used only to heat the heated waste water, so one can assume that the fish farm uses a quantity of waste heat proportional to the ratio of the water consumed in the live fish farm and the circulation consumption of the atomic or thermal electric power plant. When the water consumed by the fish farm is 7.6 m^3/s, the amount of low-potential heat used is 9.2×10^6 with an average thermal output of 1130 GJ/hr, which is 14% of the waste low-potential energy of one unit of the plant.

The cost price of the fish farm product can be further reduced by solving the problem of mechanization and automation of technological processes, eliminating manual labor, and reducing losses of the commercial product in the breeding cycles.

Methods of reducing the cost price of commercial products in pond fish farming are analogous. The level of waste heat used here can be estimated to be 6.3×10^6 GJ with an average thermal power output of 753 GJ/hr (about 9.2% of the low-potential waste energy of one unit of the plant).

When the entire cooling reservoir is used as a pasturing reservoir, all the waste energy of the four units of the plant are used. However, the efficiency of this heat use is small due to the low productivity of fish farming using natural feeds, and is no greater than 10-15% of the yield of commercial product in the live fish farm and pond fish farming.

The hothouse unit. The components of the cost price of commercial products of the hothouse are: energy 36% (including 35% commercial heat), water and use of hydrotechnical equipment 0.5%, seeds and fertilizer 0.6%, wages and other expenses 62.9%.

Cost price can be reduced here by reducing wages and the energy component. Increasing the proportion of expenditures for seed, fertilizer, and biological methods of protecting the plants, while simultaneously reducing the use of manual labor may reduce the cost price of the product while increasing its quality (ecological purity).

The main factor in the increased level of consmption of commercial heat is the significant heat losses in the hothouse when the surrounding air temperature is low, the absence of an automated system to control microclimate parameters, and an imperfect heating system which does not provide uniform heating of the air over the rows. Promising methods of reducing the cost price of products by reducing energy losses are the use of air and water heat-shielding screens, changing the design of the heat exchangers, and air and air-water heating of the hothouse.

For this type of hothouse the level of utilization of waste heat is no higher than 45-50% of the total consumption of heat and is estimated to be 23,400-28,900 GJ with an average thermal output of 75-96 GJ/hr (less than 1% of the waste heat of one unit of the plant).

The open heated ground unit. In heating with heated waste water, the thermal effect is fixed, increasing the temperature of the soil layer compared with the control unheated region. The average monthly temperature of the soil at a depth of 20 cm in the heated section drops to -6.5°C. In summer in the heated section it does not fall below -2 to +3°C, while in the control region it drops to -6.5°C. In summer in the heated section the temperature reaches 24-27°C; in the control region, it only reaches 20-22°C. The supply of additional heat from the heating system leads to a longer heating and cooling period of the soil, as well as a shift in the heating chronogram over time compared with the natural temperature pattern of the soil.

Compared with the unheated region, soil heating makes it possible to start vegetables 10-15 days earlier, and, consequently, to use the earlier harvests. Irrigation within the soil, combined with heating, makes it possible to provide additional heat by watering with heated water. Irrigation in the soil makes it possible to prevent the soil from drying out in the region of the heating pipes and eliminates soil processing after watering.

The following results were obtained in the experimental section in 1991-1992. The yield for the heated section was higher than the yield of vegetables in the control section: tomatoes by 50%, cabbage by 70%, lettuce by 20%, cucumbers by 140%, and carrots by 45%.

The level of use of waste heat by heated ground is theoretically unlimited (up to 100% of the total amount of waste heat depending on the area of the section). However, practically, heating of a region of soil more than 1000 hectares in area is unrealistic due to the technical problems of equipment and the use of this type of system.

Thus, when a heating area of 1000 hectares is reached, 1800 GJ/hr of waste heat is used (23% of the total amount of waste heat of one unit of the plant).

Moreover, in heated soil sections 1000 hectares in area one can obtain an additional energy effect associated with the increased vacuum in the condensers when some of the heat load is removed from the cooling reservoir. The temperature of water cooled in the reservoir may drop by 0.7-0.8°C, which for an average drop in turbine power of 2 MW/°C provides a power increase of 1.4-1.6 MW.

The biological melioration unit. The comprehensive biomelioration cooling reservoir makes it possible to reduce the mass of phytoplankton by almost a factor of four, increase the clarity of the water by a factor of 2, develop the area of habitation of macrophytes by a factor of 5, and increase the yield of fish in the reservoir by a factor of 4-5.

Improvement in the ecological state of the water ecosystems is reflected by the water quality indicators, and this helps reduce negative sedimentation processes on the walls of the condenser pipes, increase the operational quality of the condenser system, and reduce power loss in the turbine.

Utilization of organic wastes unit. Methane fermentation yields ecologically pure fertilizers: weed seeds, disease-carrying microorganisms, and the unpleasant smell are eliminated. This technology makes it possible to almost completely eliminate the loss of nitrogen in manure (reducing losses from 30-60% with existing means of utilization to 1-2%), and convert a significant amount of difficult to assimilate nitrogen compounds into easily accessible ones by the activity of microorganisms. Fermentation releases a significant amount of biogas (4-5.8 l/day from 1 liter of reactor volume) consisting of methane (60-70%) and carbon dioxide (30-40%). The methane can be used to prepare feed additives and the carbon dioxide can be used to feed plants.

Based on the information that has been presented, one can conclude that, despite the imperfect constructions and equipment used in the hothouse of the EBC KAPP, the expediency of creating these complexes is obvious. In complex climatic conditions they provide stable productivity and a yield of commercial products, as well as substantial savings of energy and raw materials.

Concept for the development of the EBC

It has been proposed to expand the composition of the EBC to create a closed agricultural production cycle providing basic food products (butter, milk and milk products, chickens, eggs, fish, vegetables, and grains) to the population of the region near the atomic or thermal electric power plant. The problem of feed should be solved by production within the system.

For example, for a population of 45,000, the problem can be solved by creating farms to produce milk and beef with 4800 cows with a closed technological production cycle (milk 1962.20 tons, meat 1575 tons), enterprises to produce eggs and chicken meat (20 million eggs and 1080 tons of meat), farms to produce pigs (1215 tons of meat), a fish farm complex (1215 tons of fish), vegetable production (2050 tons on 6 hectares of closed ground and 3350 tons on 194 hectares of open ground). To provide feed for the entire production cycle, 551,650 feed units, requires division of feeds into plots with an area of 13,200 hectares. To process feed one must create feed shops with three lines to produce feed (for large cattle and pigs, 210, for chickens 40, and for fish 37,000 feed units per year). About 40-50% of the main product is to be processed and placed in long-term storage (for a year). Thus, the EBC includes a storehouse with cold rooms (0 to -20°C) and cooled rooms (1-5°C).

To use the technological cycle of combined acquisition of heat and cold one must more completely solve the problem of utilizing the waste heat of the hothouse. The storehouse should be near the hothouse. At the same time, the problem of supplying power for the production of mushrooms can be solved in a 2000 m^2 area. More than 60% of the hothouse can be built with a film covering and a thermal screen tent. Each production group is served by equipment to utilize organic wastes.

The fish farming unit will raise, in addition to fish, crayfish, and shrimp, which are not only a valuable food product, but also monitors of the water environment.

The proposed EBS can simultaneously solve a number of very important social, ecological, energy, and technical problems: reliable provision of food products to the populace, the creation of additional jobs, increased use of waste heat, reduction of transportation, etc. Moreover, the EBC will be converted into a center for the development of the agricultural infrastructure of the region, oriented toward supplying state farms and other farms with products in short supply (young stock), feeds, and fertilizers, taking raw materials from them for processing with subsequent long-term storage. The social significance of the region's energy program will increase.

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INDUSTRIAL ENGINEERING

End Effectors of Automatic Assembly Manipulators

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[Article by M. A. Bostan, A. I. Botez, V. Ye. Dulgeru, and G. S. Demente, I. D[illegible] [illegible]]

[Abstract] Prototypes of metal-cutting assembly tools and effectors (hands) have been built at the Kishinev Polytechnic Institute according to very original designs: a gripping device, a fastening device, and a combination gripper-fastener. These devices are ready to operate in the precession mode with a speed reducing gear transmission where up to 100 % of all teeth can be simultaneously engaged so as to ensure a high load capacity and a high kinematic precision. The device for gripping cylindrical parts on their either outside or inside surface includes, in

addition to a micromotor and a precessing speed reducer, a planetary gear train with two rows of z teeth meshing with a stationary cogwheel on one side and with two conical gears on the other. These conical gears, one with z+1 teeth and one with z-1 teeth, are each coupled through a spline to a collar. Between the two collars is mounted a thrust bearing. The collars are also coupled each to a pin for gripping a to be assembled part at their cylindrical surfaces. The small and simple fastening device for connecting threaded parts includes a pneumatic motor whose working wheel has a skewed hub and is mounted on rollers between gears of a precessing planetary gear train, the driven gear of the latter being coupled to a shaft. The combination gripper- fastener for assembly of thrust rings includes two separately movable carriages on guide bars, each coupled to its drive by a threaded hemiprism and a screw. On the inner vertical wall of each hemiprism is mounted a a rotatable disk carrying a release mechanism, both disks being rotated into their working position during adjustment of the manipulator hand. The design of these devices included an analysis of stresses and strains, dependent on the elasticity of materials involved analysis, taking account not only both elasticity and geometry of the materials but also the parameters. Laboratory tests have yielded generally satisfactory results. It may be necessary to correct some dimensions, especially the eccentricity. All three devices are recommended for use with automatic manipulators in automobile manufacturing plants "Togliatti" in Volzhsk and "Azovmash" in Mariupol. Figures 4.

Special-Purpose Welding Equipment for Dairy Industry

947F0111A Moscow SVAROCHNOYE PROIZVODSTVO in Russian Nos. 11-12, Nov-Dec 93 pp. 14-16

[Article by M.K. Lyubimov, engineer, L.I. Akulov, engineer, and V.A. Seryeznov, engineer, Scientific-Industrial Association "Scientific Research and Design Institute of Experimental Machine Building Technology"; UDC 621.791.03-52:637.1]

[Abstract] Within the framework of the economic conversion program, a series of special-purpose automatic welding equipment has been developed for use by the dairy industry: 1. SA-531 automatic assembly welder lays up to 1200 mm long seams at speeds of 4.5-45 mm/h on 0.8-3.0 mm thick and 450- 1200 mm in diameter pipes, using a nonconsumable (tungsten) electrode under a gaseous shield with or without a filler rod and with a protective copper lining underneath the seam root; 2. SA-574 automatic assembly welder lays up to 3000 mm long seams at speeds of 6.5-45 mm/h on 2.0-4.0 mm thick and 1200- 3000 mm in diameter pipes, using a nonconsumable (tungsten) electrode under a gaseous shield with or without a filler rod and with a protective copper lining underneath the seam root; 3. SA-566 automatic argon-arc welder lays seams on 0.7-2.0 mm thick and 400-1200 mm in diameter pipes at speeds of 5-28 mm/h in either continuous or pulse mode of operation using a nonconsumable (tungsten) electrode, with or without a filler rod; 4. SA-568 automatic argon-arc welder lays up to 2500 mm long circular seams at speeds of 1.7-55 mm/h on 1.0-3.0 mm thick and 30-100 in diameter straight pipes, using a nonconsumable (tungsten) electrode with or without a filler rod and with injection of argon gas; 5. SA-569 automatic argon-arc welder lays up to 1000 mm long circular seams at speeds of 1.7-55 mm/h on 1.0-3.0 mm thick and 30-100 mm in diameter bent pipe fitting using a nonconsumable (tungsten) electrode with or without a filler rod and with injection of argon gas; 6. SA-595 automatic welder for water heaters and MP-250 dairy washers closes the cylindrical wall with a straight seam and joins the round bottom to it with a circular seam, using a consumable electrode under an Ar + CO_2 shield; 7. SA-596 automatic welder joins bottom and lid to wall of cream maturing vessels, using a nonconsumable electrode with a filler rod; 8. SA-597 welder lays triple-loop seams on cheese vats, using a nonconsumable electrode and a filler rod; 9,10. Automatic truck-mounted welders in TE-68-M7533/755 stands for assembly of ellipsoidal milk transport tanks made of aluminum alloys; 11. 53/M "Kontakt" [Contact] semiautomatic gun for argon-arc spot welding with a consumable electrode. The overall sizes these welding machines range from 700x1000x1500 mm^3 (SA-569) to 1600x2200x7000 mm^3 (SA-574). Figures 4; tables 1.

Software for the Automated Transportation and Accumulation System of a Precision-Assembly Flexible Production System

947F0128A Moscow VESTNIK MASHINOSTROYENIYA in Russian No 3, 1994 pp 23-26

[Karpov, A. V. and Rabinovich, L. A., Cand Tech Sci, Volgograd GTU; UDC 621.81.002.72:519.688

[Abstract] Software for the automated transportation and accumulation system of a flexible production system used for precision assembly of groups of parts is written in such a way as to optimize the procedure, with the minimum degree to which such groups are unfinished being the optimum criterion. Dynamic programming based on Bellman's optimum principle is suggested as the basis for writing such software. The series of steps taken to find the optimum sequence of joining parts into groups is described. The algorithm is then applied to the particular case of fitting a shaft of variable diameter onto two bearings of different sizes resting in a housing. This approach was found to be superior to other methods in terms of the completeness of the final product. One figure, 2 tables, 4 Russian references.

One Foot in the Market, the Other in Socialism

947F0127A Moscow ROSSIYSKIYE VESTI in Russian No 31, Mar 1994 p 4

[Interview with Kriogenmash Joint-Stock Company director Vladimir Yegorovich Kurtashin by Vladimir Chuprin]

[Text] There is a region of the Moscow suburb of Balashikha that the locals have named "autogenic." This is the location of the famous Kriogenmash, the trademark of which—an eye-catching penguin, a symbol of "frost resistance"—is identically well known in steamy Africa and at the Baykonur Cosmodrome. Many machine building sectors "can't live" without installations that generate cryogenic temperatures, or temperatures close to 200 degrees below zero. This enterprise, the only one of its kind in

Russia, is on the brink of shutting down. Our correspondent interviewed Vladimir Kurtashin, general director of the Kriogenmash Joint-Stock Company, about this.

[Chuprin] Vladimir Yegirovich, quite recently the president of Russia called the state of domestic industry almost catastrophic. It was of course explained to us later on that we misinterpreted Boris Nikolayevich's words. How do you assess the crisis in production personally, apart from statements by high authorities?

[Kurtashin] Gentler terms to describe the economy can always be found in the great and mighty Russian language. But the facts speak for themselves. This is evident from the example of our city, in which all machine building plants are getting ready for summer vacation, and reducing their staffs.

Kriogenmash is also under such a threat. We see nothing of the stimuli for growth of production volume talked about in parliament and the government. Last year we reached 104 percent of our quota, and 123 in 1992. And what was the result? Of 46 billion rubles in turnover, the state collects 44 billion in taxes. We are insolvent, and even now we can be subjected to the force of the Law on Bankruptcy. As for who placed machine builders in these conditions, that's another matter.

[Chuprin] Are you really saying that you and your collective have no responsibility for this? After all, you are a joint-stock company now. I remember reading about this in the newspapers—I was glad for it. They'll finally begin to take off! But isn't the reverse happening?

[Kurtashin] True, we did transform into an open joint-stock company as of November of last year. But believe me, things haven't gotten any better. Under a planned economy we were allocated specific funds for overhaul, for development of production, and for maintenance of housing. Nothing of the sort exists anymore. What are we to do? If we believe the presidential edict, then the enterprise's fixed capital no longer includes social facilities. They are supposed to be transferred to the city's balance sheet. But the administration of Balashikha isn't taking them!

For practical purposes joint-stock companies have remained within the framework of the socialist system of production. Even though the external "shell"—free prices and prepayment—is capitalistic. We won't get very far in this way.

[Chuprin] Still, people are talking persistently about priorities today. Will cryogenics, which was quite recently the pride of Russian science, really fall into ruin?

[Kurtashin] We're still competitive in the world market. Seventy percent of our physical volume of production is for export—Bulgaria, Egypt, India, China, Thailand, Switzerland bought a facility used to study elementary particles for $1.5 million.

[Chuprin] You mean to tell me that you're still complaining even with such a potential?

[Kurtashin] The problem is precisely that we're "selling" our old accomplishments. We will now begin preparing 100 liquid-fuel tenders for the USA. You'd think we'd be happy—that's a prestigious order! A solid American railroad company has signed a contract with us. But the whole thing leaves me speechless. We designed these same tenders for ecologically harmless rail shipments for our own, Russian railroads a few years ago.

What we designed for ourselves was never called for, as if it were unneeded. No investments are being made into scientific programs, and there simply will be no one to conduct them today or tomorrow. Eighteen top-class designers have left the enterprise—not for other design offices, where they could show their stuff, but to the Mosanergo to serve as ordinary electricians. Screwing in a light bulb earns you half a lemon.

It is absolutely clear that financing of unique scientific directions must be overseen by the state. Our cryogenic complex supports all sectors of Russian production. We designed modern equipment for new forms of energy—Tokomak-7 and Tokomak-15. Our equipment is working in rocket building, and we made the first rocket engines working on liquefied natural gas and hydrogen. But now, it turns out, no one needs any of this.

[Chuprin] Vladimir Yegorovich, from my vantage point everything seems so simple. Let's say for example that you supply an air separator to Thailand at a price of $10,000. In contrast to the Cherepovets Integrated Iron-and-Steel Works, Thailand is a partner with good credit, and it pays you your money. And considering that 70 percent of the articles produced by Kriogenmash are exported, the enterprise should grow wealthy. But you're getting poorer. Why? Where is this logic violated?

[Kurtashin] Before January 1993 we could have made a profit, and we would have had enough money for everything—production, social, cultural and personal service facilities, and construction. By the way, it was precisely then that we came up with the idea of building a fabulous swimming pool for Kriogenmash workers ourselves, and we started up a shop producing plate heat exchangers—American and English firms are even now asking us to organize a joint venture on the basis of this shop. The reforms were under way, things were difficult, but producers were not being suffocated.

But what about now? The cost of metal in the London market is cheaper than in Russia. A kilogram of aluminum now costs as much as R4,000. Contracts are signed with foreign firms a year in advance, and we have no idea of how much prices of fuel and raw materials will rise.

Or consider the intergovernmental agreement with CIS countries on freight transportation. In the past, the customer paid all of the shipping costs. But now we have to pay for the part of the journey that our products make through Russia. And Russia is such a huge country. Once again, it would seem, the game is not to our advantage.

Highway robbery in the light of day. When we get computers on a barter deal, we "kick back" 40 percent of their cost. But if we are trading equipment with Switzerland, India and other countries, doesn't that mean that we're competitive, so why don't you give us some advantages? This isn't gas, after all, or oil, or timber. We invest

enormous amounts of labor into imports. But they don't even want to hear about us in the Government.

Consider value-added tax. All it does for the economy is create continuous monetary emission, and nothing more. Take our oxygen facility for example: What sort of "misadventures" must it go through? We mine the ore, and send it to an enriching factory—23 percent; we smelt it at a metallurgical plant—another 23. We pour slabs at a rolling mill—23 percent more. Then we roll it into a sheet of metal—another price hike. But after all, a sheet of metal is also a sheet of metal in Africa. What it was in the past is what it shall remain. What we've created is uncontrolled growth prices of an ever-increasing scale.

We love to make comparisons with life in America. But what did Reagan start with? He cut interest rates and reduced taxes for enterprises. Are all of our directors really saboteurs? If so, then let's get rid of them. Send in a commission from the Russian State Committee for Machine Building, look the balance sheet over, and throw the bums out. But no one ever comes here.

[Chuprin] Could it be that the Russian directors' corps is responsible for today's situation? Could it be that you aren't insistent, that you don't make demands upon the government?

[Kurtashin] It is practically impossible to get the prime minister's ear. Before, in the period of stagnation or whatever you want to call it, the general director of Kriogenmash could visit the Chairman of the Council of Ministers whenever necessary, and tell his sad stories not to his assistant but to "his honor" himself. But now there's nobody to talk to.

Once Boris Nikolayevich finally wrote a letter describing the problems both our enterprise and the sector are experiencing. It looked like things were going to start moving. I began getting phone calls from the oblast administration right away, and promises to help in some way were made. Obviously the president pulled the right strings. I know Boris Nikolayevich Yeltsin personally, and I've been acquainted with him back since the congresses of USSR people's deputies. He is an exceptionally organized and honorable person. If people hadn't been creating obstacles for him, he could have avoided many mistakes in the reforms.

[Chuprin] Vladimir Yegorovich, what in your opinion needs to be done to give producers some breathing room, have any stimuli for them to increase production volume appeared?

[Kurtashin] A document on consensus has now been adopted in the society. I feel it to be an enormous accomplishment of executive and representative power. Without beating about the bush, the president of Russia announced that there will no longer be "reds" or "whites" in our country. So let's also get away from dividing people into proponents of the marketplace and conservatives.

We need a strict inspection of [illegible] kinds of taxes. There are enough of them to make the devil himself [illegible]. Tax on land, on rail spurs, there's [illegible]. What are we anyway, an army of occupation, or the masters of our own land? Will we ever see better days?

New Approaches To Evaluating Current Endodynamics in the Caspian Region and Monitoring

947N0056A Moscow IZVESTIYA AKADEMIYA NAUK: SERIYA GEOGRAFICHESKAYA in Russian No 2, Mar-Apr 94 (manuscript received 26 Oct 93) pp 16-35

[Article by D. A. Lilyenberg, Institute of Geography, Russian Academy of Sciences; UDC 551.461(262.81): 551.24]

[Abstract] The Caspian region is the result of the interaction of the lithosphere and hydrosphere. The author examines the role of the tectogenic component among the factors affecting anomalous changes in sea level. The appearance of current vertical and horizontal movements, seismicity, ooze volcanism, fluid dynamics, etc., and their morpho-structural and geodynamic interactions are examined. Quantitative parameters of movement and variations in time and space are evaluated. The coincidence of general trends in changes of the endodynamics and exodynamics of the Caspian region is noted, as well as their periodicity and smoothness and relation to the Earth's rotation. A comprehensive geodynamic testing site is needed to monitor endodynamics and to predict inevitable natural disasters and reduce their social and economic impact. International collaboration and satellite evaluation of the current state of the region is sought. Predictions of the total sign-variable change in sea level during the next decade, century, and more are needed to develop a general strategy for safe use of the shoreline in the future. Figures 9; references 27: 19 Russian, 8 Western.

Localization of Internal Gravitational Waves in Randomly Stratified Oceans

947N0047B Moscow IZVESTIYA AKADEMII NAUK FIZIKA ATMOSFERY I OKEANA in Russian Vol 30, No 1, Jan-Feb 94 pp 91-99

[Article by A. A. Lyubitskiy and Yu. V. Tarasov; Institute of Radio Physics and Electronics of the Ukrainian Academy of Sciences; manuscript submitted 16 Nov 93, after revision 21 Jul 93; UDC 551.466.8]

[Abstract] The Boussinesq approximation was used to study the effect of fine field density stratification on small-amplitude internal wave propagation in a deep ocean with a constant Brunt-Vaisala frequency. A resonance expansion method used in Green functions was employed to obtain expressions for the second-order moment of a three-dimensional internal wave-source distribution field in a randomly stratified fluid. Inserting these expressions into the formula expressing the spatial propagation of the vertical kinetic energy of internal waves produces a solution in quadratics to the problem of spatial propagation of internal wave intensity, which, upon further elaboration, shows that the interference "capture" of internal waves during their weak dissipation on stratified inhomogeneities in an oceanic pycnocline can appear in a rather wide range of frequencies and wave numbers. The possibility of localizing wave energy along the vertical coordinate and of forming a "fluctuation" waveguide in the absence of the effects of regular internal wave refraction was demonstrated. Data from field measurements of the fine vertical structure of the density field were used to determine the wave frequency and length domain in which localized effects could appear in an oceanic pycnocline. Financial support for this study was provided by the Soros Fund through a grant (No UG-185) awarded by the American Physical Society. Figures 2; references 20: 13 Russian, 7 Western.

Modelling Non-Linear Internal Wave Propagation in a Horizontally Irregular Ocean

947N0047A Moscow IZVESTIYA AKADEMII NAUK FIZIKA ATMOSFERY I OKEANA in Russian Vol 30, No 1, Jan-Feb 94 pp 79-85

[Article by Ye. N. Pelinovskiy, T. G. Talipova, and Yu. A. Stepanyants; Institute of Applied Physics of the Russian Academy of Sciences; manuscript submitted 16 Apr 93, resubmitted after revision 24 Aug 93; UDC 551.466.8]

[Abstract] A method of numerically modelling the transformation of a non-linear internal wave in a horizontally inhomogeneous ocean was presented, using a simple approach to derive an equation describing the arbitrary geometry of internal wave motion within the framework of KdV-type evolutionary equations. Non-linear distortion and dispersion are expressed in the classical KdV equation, while horizontal inhomogeneity is expressed using the law of the preservation of energy flow along ray paths. This derivation of the generalized equation makes it possible to describe the transformation of internal wave parameters in waters with horizontal density field inhomogeneities and variable depth. The model was used to perform a series of numerical experiments on the transformation of internal waves on the southern Crimean littoral shelf. For simplicity, the analysis was limited to waves with a frequency of 5-20 c/h, where the stratification can be represented a two layers with a fixed density discontinuity at a depth of 15 m, leaving the depth of the ocean as the lone variable. The calculations showed the great variability of the internal wave field due to the combined action of non-linear distortion and dispersion and supported a detailed explanation of why non-linear deformation of a wave profile occurs, even when maximum ocean depth is factored in. Subsequent research should combine the numerical integration presented in this study with existing numerical ray charts to investigate the dynamics of internal waves in bodies of water for which there are reliable data on stratification and internal wave evolution. Financial support for this study was provided by Russian Fund for Basic Research No 93-05-8073 and the American Physical Society. Figures 4; references 16: 14 Russian, 2 Western.

Probe for Vertical Profiling of Currents and Hydrological Elements

947N0052B Moscow OKEANOLOGIYA in Russian Vol 34 No 2, Mar-Apr 94 (manuscript received 19 Apr 93) pp 303-305

[Article by V. M. Kushnir, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol; UDC 551.46.085]

[Abstract] The Marine Hydrophysics Institute, Ukrainian Academy of Sciences, developed the OLT profilograph-probe for the vertical profiling of currents and hydrological elements. The instrument is invariant relative to arbitrary spatial tilts of the system for measuring current velocity; it measures and compensates for transport velocity of probe movement relative to the ship; it measures and makes allowance for the rate of the ship's drift; it determines the spectral characteristics of noise caused by probe oscillations and filters out this noise under specific measurement conditions. The probe has a modular design, consisting of the following assemblies: three-component acoustic current meter matched with a three-component instrument for measuring the angular deflections of the probe axes relative to the axes of the geographic coordinate system; instruments for measuring temperature, relative conductivity, speed of sound and hydrostatic pressure. Digital data are fed to shipboard instruments (control, communication and measure- en units and a microprocessor). The maximum soundo h is 2000 m; the measuring channels are interro ch 0.2 s; the channels are stable for 6-8 months. The has been widely used in hydrophysical research in the Atlantic Ocean, Arctic Ocean, Red and Baltic Seas. Specific results of research in the Black Sea with the OLT are given. A photograph shows the external appearance of the instrument; a table gives its principal technical specifications. Figures 3; references 15: 8 Russian, 7 Western.

Determining Parameters of Horizontal Movement of Ship by Acoustic Method

947N0052A Moscow OKEANOLOGIYA in Russian Vol 34, No 2, Mar-Apr 94 (manuscript received 18 Aug 93) pp 299-302

[Article by V. I. Volovov and M. S. Klyuyev, Acoustics Institute imeni Ak. N. N. Andreyev, Moscow; UDC 534.24:534.87]

[Abstract] An acoustic method was proposed earlier by L. M. Brekhovskikh, et al., AKUST. ZHURN., Vol 35, No 3, pp 413-419, 1989) for measuring a small displacement of a ship in which the emitter signal relected by the bottom with normal incidence is registered by a plane horizontal receiving antenna. This method is now generalized for the case of arbitrary horizontal movement of a ship with allowance for signal lag. The movement of a ship with a receiving antenna is regarded as translational with the speed of an arbitrary point of this antenna and rotational about this point. If the center of the antenna is regarded as such a point the change in spatial position of the ship can be characterized by the displacement of the center of the antenna and the angle of rotation about it. Measurements involve use of two emitters operating at different frequencies and a multielement receiving system for ensuring simultaneous and independent reception at these frequencies. The frequency spacing allows filtering of the received signal into individual spectral components without a substantial change in its correlation radius, ensuring an approximately equal accuracy of measurements at different frequencies (such as 9 and 18 kHz). Formulas are derived for computing the angle of rotation and displacement of a ship, a method is proposed for constructing the trajectory of its movement, the measurement errors are evaluated and recommendations are given on application of the method. Figure 1; references: 8 Russian.

Estimates of the Polarization Characteristics of a Lidar Signal Reflected From Sea Water Containing Stratified Inhomogeneities

947N0054 Tomsk OPTIKA ATMOSFERY I OKEANA in Russian Vol 7 No 1, Jan 94 (manuscript received 28 Oct 93) pp 67-75

[Article by M. M. Krekova, G. M. Krekov, V. S. Shamanayev, I. E. Penner, Institute of Atmospheric Optics, Siberian Division, Russian Academy of Sciences, Tomsk; Siberian Medical University; UDC 551.463.5:535.36]

[Abstract] Information on inversion layers can be obtained from polarized lidar, but one must first study the reaction of polarization to variations in the optical properties of inversion layers. This paper presents numerical and experimental results associated with the effect of optical inhomogeneities of varied origin on the polarization characteristics of a lidar signal. The dependence of the scattering index on angle and the level of depolarization in inhomogeneous water content are examined. Organic and mineral particles are considered. Small differences in the scattering matrices lead to significant quantitative changes in signal depolarization. The dependence of depolarization on sounding depth is examined. It is shown that the use of polarized radiation expands the volume of information extracted from experimental data. The calculations were done for lidar at $\lambda = 0.53$ μm. In-situ experiments were conducted at this same frequency in the Barents Sea. Makrel lidar equipment was used in the experiments. An extreme point in the amplitude-time characteristic of the signal was associated only with a change in the scattering properties of the medium, and is not accompanied by extreme changes in signal polarization structure. Figures 5; references 13: 11 Russian, 2 Western.

Laser Fluorescence Monitoring of Global Radionuclide Iodine-129

947N0053A Tomsk OPTIKA ATMOSFERY I OKEANA in Russian Vol 7 No 3, Mar 94 pp 373-377

[Article by S. V. Kireyev, Ye. D. Protsenko and S. L. Shnyrev UDC 535.37:543.426.621.039]

[Abstract] A newly developed laser-fluorescence system for detecting iodine-129 was tested in a special atmosphere. The full detection procedure is described. A block diagram with 17 components identified is used in describing the structure and functioning of the system. Taking into account the high reliability, simplicity in operation and considerable useful life of a helium-neon laser it was concluded that precisely such a laser should be used in developing laser-fluorescence systems for monitoring iodine-129 in special and natural atmospheres. The He-Ne laser used was tuned in a longitudinal magnetic field; the range of frequency tuning was 5 GHz. Iodine fluorescence was excited in a measuring cell 41 cm long with a diameter 3.5 cm. Fluorescence was excited using a plane-polarized multimode laser with a radiation power 25 mW. Iodine fluorescence was registered using interference light filters

in the spectral range 585-620 nm. The developed laser-fluorescence system makes possible reliable monitoring of the iodine-129 content both directly in the gas working medium of technological processes for the reworking of irradiated nuclear fuel and after gas purification systems at radiochemical facilities. The system also can be used in the ecological monitoring of iodine-129 in the atmosphere, including at the level of the maximum admissible concentrations. Figures 2; references 7: 6 Russian, 1 Western.

Some Problems in Atmospheric Ecologic Monitoring in Limited Areas

947N0055A Tomsk OPTIKA ATMOSFERY I OKEANA in Russian Vol 7, No 2, Feb 94 (manuscript received 15 Nov 93) pp 119-131

[Article by V. S. Komarov, Atmospheric Optics Institute, Siberian Department, Russian Academy of Sciences, Tomsk; UDC 551.510]

[Abstract] Some aspects of atmospheric ecologic monitoring of limited areas, such as cities or industrial areas, are outlined in the broadest terms, in particular, the status of development work on automated systems for the local-regional monitoring of atmospheric pollutants. A block diagram shows the approximate structure of a proposed national ecologic safety system. However, emphasis is on the principles for ecologic monitoring in limited areas. A municipal geoinformation system must have a local character and be constructed with allowance for the specifics of atmospheric-ecologic processes and the state of the environment within the limits of the monitored territory. This system must afford broad possibilities for the integration, processing, systematization and analysis of various kinds of information obtained at different scales and in different periods. The software must ensure the organization of databases with spatially distributed data reflecting the geographic, climatic, natural resource and other characteristics of the monitored area and embody a group of models of different types (physicostatistical, hydrodynamic, photochemical) necessary for the modeling of atmospheric processes and evaluation of the current and anticipated ecologic conditions. The system must have a distributed configuration ensuring on-line interaction between a data processing center, where there is a central working station, and remote stations. The system architecture must afford a possibility for highly productive operation of all its subsystems with adherence to the modular principle for constructing the system. The system must include a subsystem for the automated adoption of decisions ensuring analysis of complex ecologic situations arising in the monitored area, evaluation of the possible consequences of different scenarios of their development and formulation of recommendations to environmental protection agencies for making sound decisions on minimizing the losses inflicted on the environment. The system must be rapidly integrable into higher level information systems. [The structure and functioning of a system of this class are described in an article by V. Ye. Zuyev, et al. in this same issue of the journal (pp. 132-145)].

Geoinformation Approach to Organizing Automated Information Systems for Regional-Local Monitoring of Atmospheric Pollutants

947N0055B Tomsk OPTIKA ATMOSFERY I OKEANA in Russian Vol 7 No 2, Feb 94 (manuscript received 30 Jun 93) pp 132-145

[Article by V. Ye. Zuyev, V. S. Komarov, A. N. Kalinenko and S. A. Mikhaylov, Atmospheric Optics Institute, Siberian Department, Russian Academy of Sciences, Tomsk; UDC 551.508:91.002.03]

[Abstract] The general principles for organizing regional and local geoinformation systems (GIS) for the monitoring of atmospheric pollutants are outlined. A two-page block diagram clarifies the structure and functioning of such a system, accompanied by a brief description of each subsystem. The central unit of the proposed configuration is a working station which by means of a regional computer network is connected to a number of microcomputers which in turn are connected to measuring systems and sensors. The lower level microcomputers collect the measurements from the monitored area, reduce the received data to a standard form and ensure its initial processing. These data are then relayed to the working station for storage and subsequent higher level processing. Access to the data received in the course of ecologic monitoring is ensured in an interactive multiuse mode via a local computer system. Facilities will be available for the output and dissemination of graphic and video information, including hard copies of cartographic and tabulated compilations. Another block diagram serves as the basis for a description and discussion of a local GIS for laser atmospheric ecologic monitoring. Figures 3; references 19: 13 Russian, 6 Western.

Climatic-Ecologic Monitoring of Siberia (CEMS): Physical Research Program on Local, Regional and Global Atmospheric Changes

947N0055C Tomsk OPTIKA ATMOSFERY I OKEANA in Russian Vol 7, No 2, Feb 94 (manuscript received 15 Nov 93) pp 146-162

[Article by M. V. Kabanov, Optika Design-Technological Institute, Siberian Department, Russian Academy of Sciences, Tomsk; UDC 551.50- 59;614.7]

[Abstract] A climatic-ecologic program for Siberia (CEMS) was adopted in May 1993. The objective is to obtain not only continuous series of observations for all the principal parameters of the Siberian air basin, but also to analyze the monitoring results for evaluating and predicting climatic-ecologic changes of critical importance in the strategy for socioeconomic development in Siberia. The following objects of monitoring are discussed: meteorological and thermodynamic state of atmosphere; atmospheric dynamics; atmospheric aerosol, cloud cover and precipitation; ozone and ozone cycle components; atmospheric gases; atmospheric radiation; radio wave radiation; atmospheric electricity; physical state of underlying surface; physical state of upper atmosphere; atmospheric radioactivity; cosmic, astrophysical and geophysical phenomena;

biomedical consequences of climatic-ecologic changes (the discussion of each of these is accompanied by information on the technical means to be used in such monitoring). The following priority objectives of fundamental research are examined: atmospheric greenhouse effect; atmospheric stratification; atmospheric circulation and transboundary transport of air masses; interaction between atmosphere and underlying surface; balance and transboundary transport of atmospheric pollutants; methodological principles of climatic monitoring. A table gives the organizational-technical structure of the CEMS network, providing information on regional breakdown and principal participating organizations; a map shows the distribution of climatic-ecologic monitoring facilities in Tomsk and Kemerovo Oblasts. Figure 1; references: 23: 21 Russian, 2 Western.

GOROD System for Routine Monitoring of Air Basin Pollution of Industrial Centers

947N0055D Tomsk OPTIKA ATMOSFERY I OKEANA in Russian Vol 7, No 2, Feb 94 (manuscript received 15 Nov 93) pp 163-176

[Article by Yu. S. Balin, B. D. Belan, A. I. Nadeyev and M. V. Panchenko, Atmospheric Optics Institute, Siberian Department, Russian Academy of Sciences, Tomsk; UDC 681.3:628]

[Abstract] The described automated system for the routine monitoring of an air basin is intended for determining the pollution level in the atmospheric surface layer; measurements of the volume and quantity of effluent from sources situated in the monitored area; detection of the paths of propagation of pollutants over a city; study of individual and distributed effluent sources; observation of the behavior of photochemical processes; collection, processing, storage and dissemination of data. The system is organized on the centralized principle, consisting of: central control point with panoramic photometer, sodar, radio channel receiving point; several lidars; two mobile stations; surface monitoring points. A block diagram of such a monitoring system is given. The lidars are on tall buildings or towers; their number is dependent on the extent of the monitored area, air pollution level and location of effluent sources; lidar specifications are given in a table. One mobile station is of the traditional type; the other carries a Raman lidar. The different atmospheric components which are to be detected are listed and a system operation algorithm is presented. After reviewing foreign experience in organizing and operating such systems, a program is outlined for the "Gorod" ["City"] system which is visualized and the individual stages in implementing the program are discussed. Initial work along these lines has already been initiated. Figures 2; references 54: 32 Russian, 22 Western.

EKOLID Automated Mobile Station for Diagnosis of Atmospheric Industrial Pollution

947N0055E Tomsk OPTIKA ATMOSFERY I OKEANA in Russian Vol 7 No 2, Feb 94 (manuscript received 15 Nov 93) pp 177-181

[Article by V. F. Baryshnikov, L. D. Zemlyanovskiy, Yu. A. Ivakin, V. L. Perovskiy, A. A. Teleganov, A. A. Tikhomirov, A. P. Cherepanov and I. Ya. Shapiro, Optika Design-Technological Institute, Siberian Department, Russian Academy of Sciences, Tomsk; UDC 551.510]

[Abstract] The article gives a description and the technical specifications of the EKOLID automated mobile atmospheric monitoring station for the routine detection and measurement of the concentration of technogenic gas and aerosol pollutants in the air over populated places and industrial zones and for mapping the state of the air basin at the scale of a large city. The possibility for making a short-range prediction of the development and transport of dangerous gas and aerosol effluent is examined. Since the station is intended for measuring gas pollutants in both residential and industrial zones the requirements on the dynamic range of measured parameters are rather high. A list of the measuring instruments (fluorescent gas analyzer, chemiluminescent gas analyzer, atomic absorption gas analyzer, flame-ionization gas analyzer, laser densimeter, ultrasonic thermoanemorhumbometer, acoustic sounder) making up the station, the measurement range of each and their corresponding errors is given and the importance of each is discussed. The station also includes an IBM PC AT-286. A block diagram of the station is given with 13 components identified. All the instrumentation is mounted in the body of a van on individual shock absorbers. A map on which are plotted the concentrations of contaminants and meteorological parameters is displayed on a color monitor or can be printed out in gray gradations, accompanied by a table giving the number of the control point, measurement time and other pertinent data. The station is serviced by two operators. It operates reliably at temperatures from -10 to +35°C. The full setup time does not exceed 80 minutes. Figures 3; references: 2 Russian.

Possibility of Using Lidar Wind Sounding in Climatic-Ecologic Monitoring of Limited Areas

947N0055F Tomsk OPTIKA ATMOSFERY I OKEANA in Russian Vol 7 No 2, Feb 94 (manuscript received 15 Nov 93) pp 182-189

[Article by V. S. Komarov, V. I. Akselevich, A. V. Kreminskiy and G. G. Matviyenko; Atmospheric Optics Institute, Siberian Department, Russian Academy of Sciences, Tomsk; Russian State Hydrometeorological Institute, St. Petersburg; UDC 551.510;551.501]

[Abstract] A study was made of the results of a statistical evaluation of the accuracy of lidar wind observations made using a wind lidar developed at the Atmospheric Optics Institute. The study included a comparison with corresponding wind sounding data registered using the standard "Meteor" system. All observations were made in the Tomsk region during the period 3 May-6 June 1990. There were about 40 (26 synchronous) observations of the wind profile in the layer 200-1200 m. It was found that the wind lidar data have a definite systematic error which is insignificant in magnitude at lower levels such as 0.3 and 0.5 km but considerably greater at higher atmospheric boundary layer levels. Lidar observations (in comparison with radiosonde observations) give exaggerated estimates for the zonal component of wind speed and understated values for the meridional component. However, data from

this wind lidar can be used directly (without corrections) in climatic study of the wind regime in the boundary layer; correction (for the systematic error) is mandatory if the data are used on an on-line basis, including in the prediction of the evolution of atmospheric pollution. References: 8 Russian.

Parametrization of Pollutant Transport in Atmosphere of Large City

947N0055G Tomsk OPTIKA ATMOSFERY I OKEANA in Russian Vol 7 No 2, Feb 94 (manuscript received 15 Nov 93) pp 204-212

[Article by L. T. Matveyev and S. A. Soldatenko, Russian State Hydrometeorological Institute, St. Petersburg; Military Engineering-Space Academy imeni A. F. Mozhayskiy, St. Petersburg; UDC 372.21.51.27]

[Abstract] Applying the concepts of similarity and dimensionality theory, parametrizations are given for convective and turbulent vertical influxes of a pollutant which play a definite role in the formation of pollution levels near the surface and which are needed when constructing a model for the area of a large city (0.5-1.0 million people). The presented model is proposed because despite the extensive literature devoted to this problem numerous questions remain unanswered. Using this model, a solution is given for one very simple case. Qualitatively this makes it possible to ascertain the role of meteorological factors in forming the pollution levels in an urban atmosphere. After rewriting the initial equation it is solved by numerical methods. Each term in this equation is examined. Allowance is made for the influence of both nonstationarity and advective influx of a pollutant. Particular attention is given to the relaxation time τ, a quite complex function of pollutant particle size and size of cloud (fog, precipitation) droplets. A table gives pertinent τ data for rains of different intensity, drizzle, fog and different cloud genera. The model is consistent with experimental data and makes it possible to determine the influence of a wide range of factors on the profile of the concentration of a pollutant. References: 14 Russian.

Regional Model of Atmospheric Transport of Conservative Contaminants

947N0055H Tomsk OPTIKA ATMOSFERY I OKEANA in Russian Vol 7 No 2, Feb 94 (manuscript received 15 Nov 93) pp 213-222

[Article by S. A. Soldatenko and O. M. Sobolevskiy, Military Engineering-Space Academy imeni A. F. Mozhayskiy, St. Petersburg; UDC 551.510.42:551.513]

[Abstract] A three-dimensional nonstationary regional model of atmospheric transport of contaminants is described. It represents one of the blocks of an ecologic-economic model of a region. The contaminants are assumed to be multicomponent and chemically passive. The processes of atmospheric propagation of contaminants are described by the transport equation with allowance for turbulent exchange, sedimentation, washing-out by precipitation and exchange processes between the atmosphere and the underlying surface. The tropopause is regarded as the upper boundary of the transport model for most anthropogenic and natural aerosols and therefore an appropriate boundary condition is written. After defining the initial conditions for solving the fundamental transport equation it is shown that a solution can be found by numerical methods if the wind speed vector components, turbulent exchange coefficient and aerosol sources and sinks are stipulated. The principal solution method is the splitting of physical processes. First the advection equation is solved, then the turbulent diffusion equation, and then an equation describing transformation processes. In the advection stage the numerical TVD (Total Variation Diminishing) scheme is used, but in the turbulent exchange stage an implicit scheme is employed. The numerical model is developed in a grid measuring 40 x 40 units with a 100-km interval. Vertically the grid has a variable interval: from 150 m in the boundary layer to 500 m in the free atmosphere. Testing of the model revealed that it is suited for solving regional ecology problems. Figure 1; references 9: 6 Russian, 3 Western.

AGRICULTURAL SCIENCE

Bridge Technology in Plant Breeding

947C0299A Moscow SELEKTSIYA I SEMENOVODSTVO in Russian No 4, 1993 pp 39-40

[Article by N.I. Khabrat, "Breeding Technology" Scientific Industrial Association, I.P. Vyalov and B.O. Kuzmin, Scientific Research Institute of Potato Husbandry; UDC 631.3

[Abstract] Cursory description is provided for bridge-like chassis that moves along rails and is suitable for use in 6 ha controlled environment plant breeding operations. The electrically powered 1000 kg capacity cars can move at a maximum speed of 3.6 km/h. The system can operate in a manual or automated mode and has been used for fertilization, irrigation, pesticide spraying, and so forth. Soil compaction and disruption is avoided, the system is available round-the-clock and is not affected by soil moisture as is the use of tractors.

Hard Spring Wheat Saratovskaya-59

947C0229B Moscow SELEKTSIYA I SEMENOVODSTVO in Russian No 4, 1993 pp 42-44

[Article by N.S. Vasilchuk and V.M. Sinyak, cands. biol. sci., and V.I. Kasatov, senior fellow, Scientific Research Institute of Agriculture of the Southeast; UDC 633.112.1 321:631.526.32]

[Abstract] The newly bred hard spring wheat Saratovskaya-59 (Leucurum 1943) has been shown to be well suitted to the conditions of Saratov Oblast, exceeding in many respects Bezenchukskaya-139. The final breedings going into its production involved crossing World Seeds MP-13 (USA) and Melyanopus 1700. Field trials in the 1987-1992 period provided the following data: average grain yields of 2.05 tons/ha, weight of 1000 grains 41.6 g, plant height 88 cm, grain proteins 15.2% and carotenoids 504 μg%, and a gluten index of 52 ml on SDS sedimentation. Saratovskaya-59 thus meets world standards and should compete well on the open market.

Winter Wheat Suzorye

947C0299C Moscow SELEKTSIYA I SEMENOVODSTVO in Russian No 4, 1993 pp 44-46

[Article by I.K. Koptik, G.V. Budevich and A.V. Misko, Belarusian Scientific Research Institute of Agriculture and Feeds ; UDC 633.111.1.324:631.526.32]

[Abstract] Suzorye, a new lutescens variety of winter wheat, has been obtained from an ((Maris Huntsman x Yershovskaya-6) X Berezina) F_1 population. Field trials conducted over a four years period (1985-1989) in controlled environments yielded a mean grain harvest of 8.45 tons/ha (maximum 9.6 tons/ha), while actual yields on farms in Belarus averaged 5.08 tons/ha. Optimum planting time in Belarus is within the September 1-10 timeframe, with application of potassium fertilizer in early spring recommended for melting ground ice to facilitate germination.

Winter Wheat Volgogradskaya-84

947C0229D Moscow SELEKTSIYA I SEMENOVODSTVO in Russian No 4, 1993 pp 46-48

[Article by L.A. Zhivotkov and N.I. Blokhin, Mironovka Wheat Institute imeni V.M. Remeslo, V.N. Molchanov and G.S. Kolisnichenko, Volgograd Experimental Station; UDC 633.111.1 324:631.526.32]

[Abstract] Volgogradskaya-84 is a variety of winter wheat that in 1978-1981 trials was shown to resemble Mironovka-808 in many respects, and at times exceeded the latter in yields. The highest yields of approximately 8.2 tons/ha were obtained in Crimea, Ukraine, but good yields were also obtained in Moldova and Russia. Harvests, however, are strongly dependent on planting time, and late sowing (end of September, beginning of October) significantly reduced yields. Finally, Volgogradskaya-84 wheat has been observed to be highly responsive to fertilization with phosphorus and nitrogen at sowing time.

Winter Triticale ADM-5

947C0229E Moscow SELEKTSIYA I SEMENOVODSTVO in Russian No 4, 1993 pp 48-49

[Article by D.I. Patseka; UDC (633.11+633.14)324: 631.526.32]

[Abstract] The newly developed triticale ADM-5 at the Mironovka Wheat Institute has been shown to give an average yield of 8.43 tons/ha, with a mean weight of 56-61 g/1000 grains. The grains yield flour with excellent processing qualities. In addition, ADM-5 has been shown to be highly resistant to freezing as well as fungal, viral and bacterial infections. Cultivation of ADM-5 began in 1992 in the following areas of Ukraine: Odessa, Donetsk, Dnepropetrovsk, Lugansk, Nikolayv, Kirovograd and Carpathian oblasts and Crimea.

BIOTECHNOLOGY

Novel Synthesis of (20S)-3β-Hydroxycholesta-5,22(E)-diene-24-one

947C0266A St. Petersburg ZHURNAL ORGANICHESKOY KHIMII in Russian Vol 29 No 6, Jun 93 (manuscript received 05 Feb 93) pp 1368-1371

[Article by V. A. Khripach, M. I. Zavadskaya, A. I. Kotyatkina, O. A. Drachenova, Bioorganic Chemistry Institute, Belarus Academy of Sciences, Minsk; UDC 547.924]

[Abstract] This paper details the conversion of 20-isoxazolil steroid into a steroid enone, a precursor of brassinosteroids; 23- deoxyantheridiol and some other natural steroids. In the past the formation of the chiral center of C^{20} has been a problem. However, the authors have found that reduction cleavage reaction of the isoxazole derivatives reveals new possibilities for solving this problem. Because the novel steroids have unique properties and hold promise for applied use and occur quite rarely in nature, the synthesis of synthetic counterparts is urgent. Figures 3; references 8: 2 Russian, 6 Western.

Extraction of the Myelopeptide Influencing Human Leukemic K-562 Cell Differentiation

947C0288A Moscow IMMUNOLOGIYA in Russian No 5, Sep-Oct 93 (manuscript received 7 Aug 92) pp 37-39

[Article by O. M. Chervyakova, R. A. Stavchikov, T. A. Roslavtseva, A. M. Sapozhnikov, L. A. Fonina, A. A. Mikhaylova, Shemyakin Institute of Bio-Organic Chemistry, Russian Academy of Sciences, Moscow; UDC 612.419.017.1.08]

[Abstract] Medications consisting of various myelopeptide compounds have been successfully used against various pathologies. However, it has been unclear which myelopeptide compound acts on which pathology. Myelopeptides have an immunoregulatory effect and a neurotropic effect. They also have a distinct effect on cell differentiation and proliferation. Individual compounds capable of causing the differentiation of erythroid leukemic human cell line K-562 were extracted from a myelopeptide mixture. One active compound was found. Experiments revealed that the active myelopeptide compound acted on the expression of surface antigens. Erythroblast surface antigen expression was reduced. The expression of myeloid antigen (X-hapten) was increased. It is this myeloid antigen that causes differentiation of K-562 cells. Figures 2; table 1; references 13: 10 Russian, 3 Western.

ICO-60 Monoclonal Antibodies Against Antigen CD18

947C0288B Moscow IMMUNOLOGIYA in Russian No 5, Sep Oct 93 (manuscript received 18 Jun 92) pp 40-42

[Article by A. Yu. Baryshnikov, A. U. CHokobayeva, Ye. A. Frolova, Scientific Research Institute of Expeimental Diagnostics and Therapy of Tumors, Moscow; UDC 612.112.94/.95.017]

[Abstract] Monoclonal antibodies were obtained which act on the CD18 antigen; the characteristics of the antibodies were determined. Monoclonal antibody ICO-60 reacted with lymphocytes, T-cells, granulocytes, monocytes, thymocytes, and some B-cell and myeloid cell lines. It did not react with erythrocytes and thrombocytes. ICO-60 was found to have a spectrum of effects similar to monoclonal antibody M232, especially with regard to lymphocytes. Further experiments revealed that ICO-60 and M232 recognize different determinants (ICO-60 antibodies detect a new epitope of the CD18 antigen which is different from the epitope detected by M232). Tables compare reactivity for the two antibodies for various cell types. ICO-60 and M232 do not block each other. Figures 3; tables 3; references 3 (Western).

Evaluation of the Immune Status of Employees of Large Chemical Plants in Donbass

947C0288C Moscow IMMUNOLOGIYA in Russian No 5, Sep-Oct 93 (manuscript received 28 Sep 92) pp 57-59

[Article by V. M. Frolov, N. A. Peresadin, V. Ya. Vitrishchak, A. M. Petrunya, Lugan Medical Institute; UDC 616-092:612.017.1]-02:613/632[477/61.62]

[Abstract] Employees of the chemical industry suffer from a high rate of illness. Immune system shifts precede other indications of illness brought on by pollution and toxins. Employees of large chemical plants in a small area of the Donbass region were studied. The immune states of 612 blue-collar workers directly in contact with chemicals, 216 white-collar workers, and 135 individuals living in a region outside the industrial emissions zone were studied. Absolute numbers of blood components were determined, and in some subjects monoclonal antibodies were used for the study. Concentrations of substances such as propylene glycol were also determined. A number of specialists examined the subjects. Blue- and white-collar workers presented with a secondary immunodeficient state of T-lymphopenia, unbalanced regulatory subpopulations of T-lymphocytes, and elevated CIC level, and a reduced functional activity level of the macrophage phagocytic system. Blue- and white-collar employees working at the plants for less than five years presented with signs of B-cell immune hyperactivity (B-lymphocytosis, increased IgA and IgM levels). Some also presented with partial blockage of T-lymphocyte receptors. Monoclonal antibodies must be used to study the roles of helper and suppressor cells in these cases. Tables 2; references 14 (Russian).

Russian Warns of "Greenhouse Catastrophe"

[BIOFIZIKA Jan-Feb 1994]

[Editorial Report] A. V. Karnaukhov, a scientist at the Russian Academy of Science's Institute of Cell Biophysics in Pushchino, believes that rising carbon dioxide levels in the atmosphere could cause an abrupt and drastic jump in the Earth's mean temperature by as much as 200-300 degrees centigrade (Moscow BIOFIZIKA Jan-Feb 94). He calls for international and national programs of geobiophysical research and monitoring.

The Russian author thinks that the modest greenhouse warming expected from higher carbon dioxide levels could trigger a radical temperature increase which he calls the "greenhouse catastrophe." He believes that atmospheric warming could release additional amounts of carbon dioxide by activating subterranean decomposition of carbonates, creating a self- perpetuating warming cycle. If in addition, the Earth's thermal balance were disrupted by destruction of swamps and other biocenoses or by chemical or radioactive pollution of oceans, an "exponential, explosive" temperature increase could occur, changing Earth's climate.

On Issue of Measuring Transient Hydrodynamic Forces of Bodies in Flow

947C0278A Kiev BIONIKA in Russian No 26, Jan-Dec 93 pp 57-66

[Article by V.G. Belinskiy, V.A. Kochin, V.V. Moroz, Hydromechanics Institute at the Ukrainian Academy of Sciences, Kiev; UDC 532.5.07]

[Abstract] The negative impact of inertial components of the total force measured during the interaction of hydrobiont bodies with a flow of liquid on the accuracy of hydrodynamic force measurement prompted the development of a simplified mechanical model of a dynamometer

which equalizes the model's inertial force and makes it possible greatly to lower the relative adjusted error. This system's ability to compensate for the real inertial forces was tested on experimental units with various dynamic properties without the interference from external hydrodynamic forces; the spectral density function of the inertial force energy within a 0-20 Hz natural vibration frequency band is plotted. The use of compensating dynamometer makes it possible to lower the spectral inertial force density by 30 dB within a 0-3 Hz band, thus rendering the inertial component indistinguishable against the background of the system's mechanical noise. The use of the compensated dynamometer lowers the relative fractional error without increasing the dynamic error and makes it possible to improve the transient hydrodynamic force measurement accuracy. Figures 6; references 4.

On Mechanism of High Lift Generation During Fluttering Insect Flight

947C0278B Kiev BIONIKA in Russian
No 26, Jan-Dec 93 pp 74-83

[Article by S.A. Dovgiy, A.V. Shekhovtsov, Hydromechanics Institute at the Ukrainian Academy of Sciences, Kiev; UDC 533.6.013:577.31]

[Abstract] The inability of classical aerodynamics to explain the flight mechanism of most insects using quasisteady-state assumptions due to the high amplitudes and frequencies of the insect wing movements prompted a numerical study of the issue of high lift generation during the fluttering flight of insects where the wing motion is simulated by the Weis-Fogh model, especially for the *Encarsia formosa* hornet. The Weis-Fugh "thrust" mechanism describing the initial phase of the hornet wing deployment is a simplified model of wing pronation which is probably common among insects in one form or another. The principal assumptions and approaches used in the study are formulated, and the outcome is interpreted in the two independent domains of length and time. The effect of the flow conditions and the presence of the second wing on the lift generation, the effect of the vortex sheet forming during the wind deployment and initial circulation around the wing, the translational leading edge velocity component, the effect of the starting method during the wing spreading on the lift generation, and the vortex sheet formation patterns are plotted. The findings reveal that the development of an area of reduced pressure near the wings makes the principal contribution to the lift generation and that during a transient motion in a resting medium, lift cannot be attributed solely to circulation around the body. Transient phenomena, e.g. an increase in lift in a separation flow, are discussed. Figures 6; references 11: 3 Russian, 8 Western.

Soliton and Conoidal Gyroscopic Waves in Incompressible Liquid

947C0278C Kiev BIONIKA in Russian
No 26, Jan-Dec 93 pp 83-89

[Article by N.V. Saltanov, Hydromechanics Institute at the Ukrainian Academy of Sciences, Kiev; UDC 532.59+551.465]

[Abstract] The analytical theory of nonlinear waves, particularly solitons, which are better understood from the analytical viewpoint than the alternative phenomenon of very complex behavior of rather simple oscillatory systems, and the contribution to science made by the discovery of the "strange attractor" and its relationship to certain aspects of the turbulence theory are discussed, and the body of mathematics for gyroscopic soliton and conoidal waves is further developed and studied. The equations which describe the nonstationary motion of an incompressible liquid revolving around the z-axis are considered in a cylindrical system of coordinates. A nonlinear equation of the flow function which describes gyroscopic waves of finite amplitude in a cylindrical column of incompressible liquid is derived, and it is established that for waves whose length greatly exceeds the radius of this liquid column, the basic equation may have solutions both in the form of periodic (i.e., conoidal) or solitary waves (i.e., solitons). An analysis shows that a longitudinal steady-state wave is stable to longitudinal perturbations but is unstable to the transverse ones. The latter factor is akin to the phenomenon of focusing in the theory of nonlinear electromagnetic waves. Figures 1; references 12: 9 Russian, 3 Western.

On Phenomena Developing on Liquid Surface During Cylinder Oscillations

947C0278D Kiev BIONIKA in Russian
No 26, Jan-Dec 93 pp 93-97

[Article by V.I. Danileyko, Kyzyl Teachers Institute; UDC 629.12.072.5(031)]

[Abstract] The author's earlier study of the periodic boundary layer on a cylinder performing low-amplitude harmonic oscillations in a liquid at rest is continued, and an attempt is made to explain the unexpected result obtained in solving the above problem: during the cylinder oscillations in the liquid, peculiar secondary flows develop and impart steady-state motion in the liquid although the cylinder motion proper remains purely periodic. To this end, the solution of the problem is experimentally verified by immersing into a liquid at rest the end of the cylinder vertically restrained in a mechanical vibrator clamp which imparts in the cylinder frequency-controlled transverse vibrations within a 0-100 Hz band. The phenomena developing on the free liquid surface during transverse vibrations of the immersed cylinder are studied, and it is shown that the development of these phenomena is associated with the boundary layer's loss of stability. The new unstable state develops in the boundary layer at a strictly defined vibration frequency and is manifested in the form of radial waves on the free liquid surface around the cylinder. According to the experimental conditions, both traveling and radial gravitational-capillary waves were generated by the oscillating cylinder on the liquid surface; the radial waves are generated under the effect of the boundary layer. The dependence of the radial wave generation frequency on the depth of immersion, cylinder radius-to-amplitude ratio, and other factors is discussed. It is noted that as the cylinder is shortened, the effect of its natural flexural vibrations on the outcome of the experiment becomes diminished. Figures 7; references 3.

Invariant Structural Arrangement Pattern of Three-Link Biosystem of Animal and Human Bodies and Extremities

947C0278E Kiev BIONIKA in Russian No 26, Jan-Dec 93 pp 104-107

[Article by S.V. Pershin, Naval Engineering Academy, St. Petersburg; UDC 574.6-576.2-577.4]

[Abstract] The urgency of deciphering the structure and forming patterns of animal organisms for use in other applications, e.g., biomechanics and bionics, prompted continued attempts to establish a new universal pattern of structural arrangement of animal and human bodies and limbs on the basis of today's interdisciplinary systemic approach to the general theory of systems. In contrast to other researchers, three-link living entities are generalized by the author as three-link biosystems whose structural relations are expressed nondimensionally on the basis of a unified algorithm of the general theory of systems in the form of a numerical invariant. The findings assert that the hitherto unknown pattern of invariant structural arrangement of three-link biosystems of animal and human bodies and extremities has been demonstrated, *viz.*, simple ratios of the link lengths to their total length in each biosystem are determined by the relatively stable (from among all links) nondimensional length of the second link which varies by about one third and this link's shift from the symmetric position in the systems stably expressed by the value of the projective double relation of the interrelated system link lengths. The author asserts that his findings prove Academician V.I. Vernadskiy's tho hypotheses of the cosmic origin of the earth biosphere structures. Figures 1; references 31: 29 Russian, 2 Western.

Hydroelastic Flutter on Body of Cetaceans

947C0278G Kiev BIONIKA in Russian No 26, Jan-Dec 93 pp 117-123

[Article by A.N. Volobuyev, V.I. Koshev, V.P. Pirogov, Ye.S. Petrov, Samara Medical School; UDC 591.173]

[Abstract] The phenomenon of hydroelastic instability of the skin cover shape which may develop in swimming cetaceans, e.g., porpoises, and the three hydroelastic instability mechanisms are discussed; attention is focused on the generally bimodal hydroelastic flutter. It is noted that in actively swimming animals, the "shell mode" which includes the "wall-flow" loss of stability may be realized at high velocities. The momentum equation of laminar flow about the body is derived, and the skin vibration amplitude is assumed to be small. The problem of the cetacean elastic surface behavior in the water flow is solved, and the effect of nonpotential flow about the body on the flutter is analyzed. The additional power which the cetaceans need to overcome flutter when swimming is computed, and the similarity of the antiflutter stabilization mechanism of the cetacean blood vessels and skins is noted. The antiflutter stabilization of the cetacean skin is a method which prevents an increase in the hydrodynamic body drag when self-excited vibrations develop on the animal surface. The methods of lowering the swimming drag which are associated with enhanced skin cover innervation, making it possible locally to trace the development of turbulent vortices on each skin segment, are discussed. Figures 2; references 11: 9 Russian, 2 Western.

Interaction of Resonant Fin Propulsors With Medium

947C0278I Kiev BIONIKA in Russian No 26, Jan-Dec 93 pp 108-116

[Article by A.A. Petrov, Kmelnitskiy Technological Institute; UDC 532.012.2]

[Abstract] Recent interest in the nontraditional fin-type propulsors which, to a certain extent, emulate hydrobionts, i.e., in which resonant propulsors whose reactance determined by the mass, elasticity, and frequency of the system turns into resistance, is discussed. Such resonant ship propulsion systems are characterized by the presence of elastic elements and masses which partially move in water, making it necessary to solve the problems of hydroelasticity. The phenomena which develop under resonance and are typical of quantum mechanics are described and discussed. The hitherto unknown conditions for minimizing energy losses in elastic links of flapping fin propulsors are theoretically predicted and experimentally verified. The conditions of maximizing the system response to excitation are examined, and it is shown that one of the most important factors for maximizing the propulsor efficiency is to ensure a motion path slope of the hull-flapping fin system; a propulsion system is developed on the basis of this requirement. The design of the proposed propulsion system and deformable wedge is presented. Experimental data on minimizing the resonance energy are cited. It is noted that the deformable wedge systems can be used not only in shipbuilding but also in mechanical engineering and vibration machining devices. Figures 4; references 23.

Hydrogen Bond Structure and Elastic Properties of Films of Hydrodynamically Active Grafted Copolymers

947C0278H Kiev BIONIKA in Russian No 26, Jan-Dec 93 pp 123-128

[Article by T.B. Zheltonozhskaya, N.P. Melnik, V.I. Pavlov, N.V. Kutsevol, L.N. Momot, B.V. Yeremenko, Kiev University; UDC 532.58:678.026.3]

[Abstract] A new class of polymer compounds developed in recent years on the basis of a detailed investigation of the composition and hydrodynamic activity of mucous integument of fast swimming hydrobionts, or water-soluble graft copolymers (PS) which, like proteoglycane—the principal component of the fish mucus—not only significantly lower drag in the water but are also highly stable to degradation in a turbulent flow is discussed. The hydrogen bond structure and cohesion properties of such dextran-, sulfodextran-, and polyvinyl alcohol-based graft copolymers with side polyacrylamide chains (PAA) are examined, and the types of intermolecular H-bonds between polyacrylamide links and between the main and grafted chains are investigated with the help of infrared spectroscopy using computer processing of overlapping vibration bands. A study of the films' elasticity modulus shows that the presence of a continuous spatial grid of H-bonds in graft copolymers is consistent with the high

values of the modulus of elasticity and low values of elongation at rupture. The conclusion is drawn that the films are structurally homogeneous and may be regarded as polymer glass with a high moduli of elasticity, a well developed grid of inter- and intramolecular H-bonds, and rather uniform structure. Figures 3; tables 3; references 12: 11 Russian, 1 Western.

Mechanical Tissue Characteristics of Locomotor System of Cephalopoda Mollusks

947C0278I Kiev BIONIKA in Russian
No 26, Jan-Dec 93 pp 129-133

[Article by L.A. Zhivotovskaya, Zoology Institute at the Ukrainian Academy of Sciences, Kiev; UDC 597.31]

[Abstract] The two primal components of the locomotor system--skeletal and muscular—which transform muscular energy into work are discussed, and emphasis is placed on mechanical tissues. An attempt is made to ascertain their diversity among Cephalopoda as well as their structural arrangement and functional capabilities. The urgency of such studies is necessitated on the one hand by a lack of data on mechanical tissues on Cephalopoda—remarkable swimmers—and on the other, by the inadequate knowledge of these tissues in the remaining invertebrates. The macro- and microstructure, topography, and degree of development of the Cephalopoda's mechanical tissues are described, and their chemical composition and physical properties are discussed. A morphological functional analysis shows that the Cephalopoda's mechanical structures have a diverse structure and origin as well as functions and organizational level. The conclusion is drawn that Cephalopoda perfected their mechanical tissues in the course of evolution. For example, nekton squid has the most perfect collagen skeleton. References 9: 8 Russian, 1 Western.

On Functional Morphology of Elasmobranchia Propulsion System

947C0278J Kiev BIONIKA in Russian
No 26, Jan-Dec 93 pp 133-138

[Article by M.D. Vysotskaya, V.A. Zayets, A.P. Koval, Zoology Institute, Kiev; UDC 597.31:(591.4:591.47)]

[Abstract] Interest in identifying common patterns of the structural and functional evolution of the locomotor system and the possibility of simulating it in bionic systems prompted a comparative morphological study of the type and adaptive modifications of the individual locomotor system components of lower vertebrates. To this end, the vertebral column of some shark-family species capable of swimming at various velocities is examined morphologically, and it is shown that that lack of a sufficient number of skeletal elements in pelagic sharks is compensated for by the higher strength of their axial skeleton due to the more complicated histoarchitectonics and an increase in the degree of calcification as well as a developed system of connective tissue membranes and septa which serve as a strong "frame" for the muscles and the presence of an elastic subcutaneous shell. The vertebra calcification pattern in the caudal section of various sharks is plotted. The comparative morphological study and anatomic and histological analysis of diverse species reveal the ecological and morphological modifications which are manifested in the details of the micro- and macrostructure and reflect the species' adaptation to life under specific conditions. Figures 2; references 11: 8 Russian, 3 Western.

Genetic Distances Between Populations of Different Ethnic Groups Calculated on the Basis of the Polymorphism of DNA Isolated by a Hypervariable M13 Phage DNA Probe

947C0369A Moscow GENETIKA in Russian
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[Article by Ye.V. Semina (Barysheva), A.M. Bukina, Ye.A. Startseva, S.A. Limborskaya, and Ye.K. Ginter, Clinical Genetics Institute, Medical Genetics Scientific Center, Russian Academy of Sciences, Moscow; UDC 575.599]

[Abstract] The hypervariable M13 phage DNA probe reveals multiple loci so that the hybridization pattern of the said probe with nuclear human DNA may be termed a fingerprint. The somatic stability and strict mendelian inheritance of the hybridized fragments constituting the "fingerprint" and the significant number of hybridization bands and their relatively high population frequency characterize the said sequence as a marker that may be used successfully in genetic populations studies. In previous publications, the authors proposed a method of processing individual fingerprints where the entire area of the electrophoregram is divided into 2-mm-thick segments that for practical purposes, correspond to the thickness of a band of average intensity. Thus each individual is characterized by the filling/nonfilling of 37 discrete positions into which a 2- to 6-kb electrophoregram undergoing analysis is divided. The fingerprint's hybridized fragments possess somatic stability and are inherited in accordance with Mendel's rules. In this publication the authors report the results of their use of the M13 phage DNA probe to study five Russian populations of the Kirov Oblast, one Russian population of the city of Krasnodar, and one population from Chuvashia and one from Tuva. Blood samples were collected from the following individuals: 37 natives of the village of Kosino, 29 natives of the village of Lema, 40 natives of the village of Mukhino, 53 natives of Krasnodar, 38 natives of Chuvashia, and 35 natives of Tuva. DNA was extracted from the blood samples according to the Matthew method by phenol-chloroform extraction. The DNA of the blood samples was restricted by an excess of the enzyme Bspr1 and subjected to electrophoresis for 22 hours in TAE buffer in 0.8 percent agarose gel at V = 36 V. The DNA was transferred onto nitrocellulose filters in a solution of 1 M NHAC and 0.03 M NaOH. The DNA of each sample was then hybridized with an M13 phage DNA probe prepared on the basis of single-chain dNA of the phage vector M13mp11 by using a hybridization primer and Klenow fragment of DNA polymerase. The hybridization was conducted for 3 days. The band position analysis was performed as described elsewhare. The genetic distances between the study populations were calculated according to Nei's formula, and their similarity index was calculated in accordance with a new formula proposed by Li. The incidence of individual bands with respect to all 37

positions for all of the populations studied was examined. An incidence of 100 percent was found for the band at position 23 for all of the populations studied, and frequencies exceeding 50 percent were found for the bands at positions 5 and 14 for all of the study populations. The number of bands found per individual examined was approximately the same for all of the study populations. In the matrix of the genetic distances between study populations calculated on the basis of the polymorphism of the DNA isolated by the M13 phage DNA probe, the Russian populations turned out to be closest to one another. The dendrograms plotted on the basis of the DNA analysis were completely consistent with the a priori-hypothesized degree of actual proximity of the study populations. Specifically, the location of the Russian, Chuvash, and Tuva populations on the dendrogram corresponded to the degree of relationship between the Europeoid, transitional, and Mongoloid races, thus indicating the effectiveness of using the polymorphism of hypervariable genome loci to establish relationship between different ethnic groups. The proposed method based on using an M13 phage DNA probe was therefore recommended for genetic populations analysis and was praised for its universality for populations with varying degrees of distance from one another, including different ethnic make-up. Figures 2, tables 3; references 9: 5 Russian, 4 Western.

Functional State of the System of Xenobiotic Biotransformation in Animals Intoxicated With Diphenylamine and N-Nitrosodiphenylamine

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[Article by I. V. Semak, A. T. Pikulev, Belarusan State University, Minsk; UDC 577.1]

[Abstract] The molecular mechanisms that result in the removal of xenobiotics from the body consist of two interrelated stages—the transformation of the lipophilic xenobiotics into hydrophilic compounds, and the entry of the compounds into various conjugation reactions. The xenobiotic-induced biological effect is a function of the content and functional state of all the components of the system of biotransformation. It is important to know how the chemical structure of the xenobiotic affects its ability to induce activity in the enzymes that participate in both stages of the biotransformation. Most of the chemical compounds that have toxic, carcinogenic, or mutagenic properties induce enzymes that take part in their metabolism. Carcinogenic N-nitrosamines are considered dangerous to man and animals. The level of N-nitrosodiphenylamine in the workplace air at plants that produce resin products is 47 μg/m^3, and the unprocessed wastes at textile plants contain 20 μg/l. In light of the fact that, unlike diphenylamine, N-nitrosodiphenylamine is carcinogenic in rats and mice, the researchers here compared the action of diphenylamine and N-nitrosodiphenylamine on the system for xenobiotic biotransformation. In male albino rats who had received a single peroral administration of either diphenylamine or its N-nitroso derivative, they found that the derivative produced a 58-percent increase in the content of P-450 cytochromes and doubled NADPH-reductase activity. Neither xenobiotic had an effect on the b5 cytochrome. The researchers found that intoxication of the animals with N-nitrosodiphenylamine produced unidirectional changes in the functional state of both stages of the metabolism of the foreign compounds. Figures 1, references 22: 5 Russian, 17 Western.

Isolation and Properties of Site-Specific Endonuclease BspTS514I From Thermophilic Bacterium Bacillus species TS514

947C0377A Moscow BIOORGANICHESKAYA KHIMIYA in Russian Vol 29 No 11, Nov 93 [manuscript submitted 12 May 93] pp 1073-1076

[Article by N. P. Kovalevskaya, N. V. Zelinskaya, L. A. Zheleznaya, N. I. Matviyenko, Protein Institute, Russian Academy of Sciences, Pushchino, Moscow Oblast; Institute of Theoretical and Experimental Biophysics, Russian Academy of Sciences, Pushchino, Moscow Oblast; UDC 577.152.312'14]

[Abstract] New site-specific endonucleases *Bsp*BS31I, *Bst*BS32I, *Bsp*IS4I, *Bst*TS5I, and *Bsp*TS514I were isolated from five thermophilic soil bacteria—*Bacillus* sp. BS31, *B. stearothermophilus* BS32, *Bacillus* sp. IS4, *B. stearothermophilus* TS5, and *Bacillus* sp. TS514. The enzymes are isoshizomers of restrictase *Bbv*II. Endonuclease *Bsp*TS514I, which contains no traces of any nonspecific nuclease, was produced with two successive chromatographies on blue agarose and hydroxyapatite. The enzyme shows maximum activity in 10 mM tris-HCl buffer (pH 9.2) in the presence of 10 mM $MgCl_2$ and 50 mM NaCl at 55°C. Figures 1, references 7: 2 Russian, 5 Western.

Anticholinesterase Activity of Certain Carboranyl-Containing Thio- and Selenoesters of Acids of Pentavalent Phosphorus

947C0377B Moscow BIOORGANICHESKAYA KHIMIYA in Russian Vol 29 No 11, Nov 93 [manuscript submitted 22 Apr 93] pp 1077-1080

[Article by V. P. Balema, Ye. G. Rys, Ye. Ye. Sochilina, O. V. Yagodina, S. N. Moralev, Yu. G. Zhukovskiy, N. N. Godovikov, M. I. Kabachnik, Institute of Organoelemental Compounds imeni A. N. Nesmeyanov, Russian Academy of Sciences, Moscow; UDC 577.152.311*8.042:547.45'118.5]

[Abstract] A study of the anticholinesterase activity of carboranyl-containing thioesters and selenoesters of acids of pentavelent phosphorus determined that the introduction of carboranyl substituents into the thioester group of organic phosphorus compounds produced a greater increase in anticholinesterase activity than with thioalkyl analogs. The position of the organic phosphorus fragment addition relative to the carboranyl nucleus has a substantial effect on the ability of the compounds to interact with the cholinesterases. Figures 1, references 9: 7 Russian, 2 Western.

Heterohybridomas Secrete Monoclonal Antibodies to D-Antigen of Rhesus System

94A7C0294A Moscow BIOTEKHNOLOGIYA in Russian No 8, Aug 93 (manuscript received 09 Jun 93) pp 7-9

[Article by Ye. V. Belkina, Ye. I. Deryugina, G. Yu. Miterev, T. L. Nikolayeva, N. I. Olovnikova, G. A. Udalov, I. L. Chertkov, Hematology Research Center, Russian Academy of Medical Sciences, Moscow; UDC 577.112.825:57.083.3]

[Abstract] The objective of this investigation was to obtain lymphoblastoid cell lines that produce IgG antibodies and stabilize these lines by means of heterohybridization with murine myeloma X63- Ag8.653. The Epstein-Barr virus transformed lines producing the IgG and IgM anti-D antibodies were obtained from lymphocytes from the peripheral blood of a Rhesus-negative donor, taken 7 days after intravenous re-immunization with Rh-positive erythrocytes. The IgM secreting lines stopped growing after 10 passages in the culture and researchers attempted to keep the line alive by means of heterohybridization. The heterohybridomas produced achieved a rather high yield of secreting hybridomas, and those with the fastest growth and greatest antibody production were cloned in murine peritoneal macrophages. The stable secreters of IgM, anti-D-monoclonal antibodies were obtained as a result of five consecutive clonings. Indirect immunofluorescence with monoclonal antibodies to differentiate antigens of the leukocytes was employed to determine the presence of differentiated antigens on lymphoblastoid cell surfaces prior to fusion and on their respective heterohybridomas. The results showed that the lymphoblastoid line has a large number of antigens, while the heterohybridoma has lost many antigens, which may be attributed to the loss of chromosomes coding for these antigens. One line selected for large scale production was cultivated 15 months and during this time did not change in its growth characteristics or ability to secrete monoclonal antibodies. In conclusion, these stable cell lines that produce antibodies to the antigens in the Rh system can be used for Rh blood group system typing and for producing anti-Rh immunoglobulin, which is used in treating newborn hemolytic disease. Tables 5; references 6: 4 Russian, 2 Western.

Microclonal Reproduction of *Prunus* Genus Species

947C0296A Moscow BIOTEKHNOLOGIYA in Russian No 5, May 93 (manuscript received 05 Apr 93) pp 19-21

[Article by A. Ye. Shelifost, S. S. Kostyshin, R. A. Volkov, Chernovits State University; UDC 57.085.2:57.086.833]

[Abstract] The objective of this investigation was to develop a method for a microclonal reproduction of genus *Prunus* plants (*P. americana, P. cerasifera, P. spinosa,* and *P. domestica*). The conventional procedure used for other plants is ineffective with fruit trees, because fruit tree tissue is easily oxidized and the chemicals used as sterilizing agents only compound the problem. The tissue cultures (foliose axillary buds) were isolated in a 0.2 percent solution of ascorbic acid. A 0.025 percent solution of ascorbic acid was used to rinse off the sterilizing fluid. In addition, when attempting to reproduce fruit trees, one must take into account the seasonal physiology of the plant. In this case, the best time of year for *in vitro* cultivation is February-March, when the plants are just beginning to emerge from dormancy. At this time the plants also withstand sterilization better and quickly begin development. The data showed that the solid nutrient culture was best suited for most species and varieties. The liquid medium also worked well, but the agar medium was completely unacceptable. It was also demonstrated that it is best to pot the plants in perlite and later transplant to a 1:1:1 perlite-peat-soil mixture. This method resulted in greater than 90 percent viability of the plants. The advantages of this method indicate that it can be successfully used for large scale reproduction *in vitro* of genus *Prunus* plants. Figures 2; tables 3; references 8: 7 Russian, 1 Western.

Life Sciences Innovations

[POISK 6-19 May 1994, etc.]

Food Technology

[Editorial Report] The Scientific Research Institute for the Dairy Industry has developed a device that removes radionuclides from milk. Milk is filtered through an ion exchanger where ionites attract up to 90 percent of the cesium and iodine content and 60-65 percent of the strontium. The ionites can be used for 5 to 7 years, compared to 10 hours for zeolites used in previous filters. Together with the Russian Academy of Science's Physical Chemistry Institute, the researchers have developed processes for cleaning the filtering solution and using the radioactive wastes. The equipment, which is built to operate under extreme conditions, can also demineralize whey, purify water, increase the thermostability of milk, and achieve a predetermined mineral content in milk products (Moscow POISK No 18-10, 6-19 May 94).

Medicine

The Medikal-Z firm has developed a novel compression suit for preventing body deformations in burn patients. The suits, which are individually sewn to the patient's measurements, are in use at the Lyubertsy Pediatric Burn Center in Moscow Oblast (Moscow ROSSIYSKIYE VESTI 20 May 94).

The Viktoriya technology association in Moscow is treating cancer by laser immunostimulation of "biologically active points." The method reportedly can also be used to treat infertility and may be effective against juvenile paralysis (Moscow POISK No 18-19, 6-19 May 94).

Medical Equipment

A new device developed by the Astrofizika Scientific Production Association disinfects rooms by means of an ultraviolet lamp and short-wave generation of ozone. The portable unit, which is rated for one half-year of continuous operation, is lighter than its foreign counterparts and costs one-fourth as much (Moscow DELOVOY MIR 14 May 94).

Biographical Sketch: Geneticist, Academician Bayev

94^C0274A Moscow NEZAVISIMAYA GAZETA in Russian 5 Jan 94 p 6

[Article by A. Vaganov]

[Text] It is not coincidental and entirely predictable that he was the one to become involved in recent years in the program studying the holy of holies of nature—the genetic patterns of the human organism's functioning. Academician of Russia's Academy of Sciences Aleksandr Aleksandrovich Bayev has been moving toward this goal all his life.

An adviser to Russia's Academy of Science Presidium, a member of Polish, Czechoslovak, Hungarian, and Bulgarian academies, a member of the Leopoldina Academy and European Academy, a doctor of the Greifswald University, and a member of HUGO (Human Genome Organization) at the American Society of Biochemists and Molecular Biologists began his career as a village physician. This was back in 1927. This was followed by graduate school at the Department of Biochemistry of the Kazan Medical Institute.

As he wrote in his autobiography, "It seems to me that the fates of the people of our generation during the wars, revolutions, economic dislocation, and rigid ideological control are very interesting." In 1937, the scientific secretary of the Biochemistry Institute at the USSR Academy of Sciences was arrested on suspicion of terrorist activity. He was banished for 17 long years. But even in the Norilsk prison camp, he wrote several scientific articles. These include "On the Solar Radiation Resources in Norilsk" and "A Handbook on Infant Nutrition." In 1946, this "enemy of the people" gained permission to defend his candidate's thesis.

His life has been affiliated with the Molecular Biology Institute at Russia's Academy of Sciences since 1959. It was in the early 1960's that A.A. Bayev began deciphering the primary structure of nucleic acids. This was pioneering research in domestic science. In 1969, the team lead by A.A. Bayev was awarded the USSR State Prize—the first prize given in the field of molecular biology.

My discussion with Academician Bayev started with his admission: "As I was losing the opportunity to work near a laboratory table—and I always liked this side of scientific research—I began promoting advanced and prospective scientific trends."

The scientist's remarkable intuition remained true to him this time: back in the early 1970's, efforts in genetic engineering began in our country due to his promotional activity.

A.A. Bayev has been chairman of the Scientific Council on Russia's State "Human Genome" Scientific Program since 1989.

On 10 Jan 94 Aleksandr Aleksandrovich Bayev turned 90 years old. Academician Bayev has more than 80 years of official work experience.

Interview With Academician Bayev on Human Genome Project

94^C0274B Moscow NEZAVISIMAYA GAZETA in Russian 5 Jan 94 p 6

[Excerpts from article by A. Vaganov "Human Genome: In the 21st Century, You Will Probably Be Able to Read It Like a Book"]

[Text] And today, when we are talking about the "human genome" program, we are already hearing a sentiment toward moderating the pace of competition and placing the emphasis on coordination. **Q:** With respect to the foregoing, what can you say about the Russian segment of the "human genome" program? **A:** In Russia, the impetus toward the development of this program was given by Mikhail Sergeyevich Gorbachev. In 1987, I wrote him a letter. This is when the USSR Council of Ministers issued a decree on the "human genome" program.

The early steps inspired optimism. Twenty-five million rubles and 10 million dollars a year were allocated for the program, yet at our pace, organizational issues stretched to occupy a whole year. In essence, we began working in 1989. And very soon, our comfortable life came to an end. It came to an end as a result of the social-state progress known under the name of perestroyka. Inflation ate away at all our ruble appropriations while the foreign currency support ceased altogether. Today, the "human genome" program is experiencing considerable difficulties and has been cut back significantly.

And this is especially unfortunate since the Russian segment of the "human genome" program seriously addresses the practical factors associated primarily with human health and human social needs. The program calls for examining the molecular bases of hereditary diseases, primarily metabolic errors or enzymopathy, their biochemical manifestations, diagnostics, and prevention. Sooner or later, genetic therapy will become a reality, at least for the most common diseases whose pathogenesis is known and accessible to corrective measures. The program also covers allergies, immune deficiencies, and predisposition to cardiovascular, psychiatric and endocranial diseases. In human pathology, the issue of the origin of cancer which is the second largest cause of death occupies a special place. Since the discovery of oncogenes and antioncogenes, the concepts of the genetic origin of cancer have been confirmed. Cancer is the genome disease, at least this is how the illness is understood. The recent discoveries of antioncogenes not only expanded our notions of the mechanism of malignant cellular transformation development but also engendered hope to develop cancer therapy. In an overwhelming majority of cases, cancer is not a hereditary disease in the usual sense of this term but is a consequence of a benignly acquired genome defect of certain somatic cells. **Q:** Is the development of a "biological robot" realistic and how may this be related to the "human genome" program? **A:** This is not related to the program in any way, and the program denies the possibility or admissibility of this. And this is simply difficult to make from the practical viewpoint. And even if some maniac decides to do this, then allowing for the slow human reproduction and many

other factors, the following will happen: before the "new breed" is produced, this hypothetical maniac will die himself.

One should not think that the genes determine everything. Much in the human is determined by the living and nurturing conditions. And thus, one can produce a human "breed" but in a different, not purely biological sense, simply by learning. Q: Does this mean that the outcome of the "human genome" program cannot be used as the source data for the development of "genetic weapons"? A:And what do you think about it? Can the following situation be regarded as a genetic weapon? Certain citizen X possesses a pathological gene. So he is dispatched to another country as a "genetic weapon" and is forced to enter into a sexual relationship with women. Is this a "genetic weapon"?! In the end, [the aforementioned] radiation is also a genetic weapon. In my opinion, there cannot be biological of genetic weapons. In any case, I do not have enough imagination for this. But to spoil the genome—this we are already doing and are quite good at it.

De Novo Protein With Engineered Structural Specificity: A New Approach to Protein Engineering and Analysis

947C0229A Moscow MOLEKULYARNAYA BIOLOGIYA in Russian Vol 26, No 6, Nov-Dec 1993 pp 1242-1250

[Article by D. A. Dolgikh, M. P. Kirpichnikov, O. B. Ptitsyn, A. N. Fedorov, A. V. Finkelshtein, V. V. Chemeris; Institute of Molecular Biology imeni V. A. Engelgardt of the Russian Academy of Sciences, Moscow, and the Protein Institute of the Russian Academy of Sciences, Pushchino; UDC 577.21:322]

[Abstract] The molecular theory of protein structures was used as the basis for engineering and studying a *de novo* albebetin protein with an engineered structural specificity yet to be found in natural proteins. The tertiary structure consists of four anti-parallel β-strands covered on one side with two α- helixes. In order to obtain sufficiently stable α-helixes and β-strands, they were constructed primarily of leucines (for the helixes) and valines (for the strands). Additional stability was ensured by polarizing the ends of the α-helixes and by placing hydrophilic charged amino-acid residues in the extreme β-strands, and residues practically uncharged at neutral pH levels in the middle strands. This primary structure was used to obtain the corresponding nucleotide sequence for the *de novo* gene, allowing for E. coli codon frequency. Half of the albebetin gene was synthesized, cloned, and then duplicated in plasmid to form the complete gene. For the purposes of this study, a method for quickly testing for the compactness and stability of the albebetin structure was developed. The test consists of cloning the protein into plasmid and obtaining the mRNA, producing the desired quantity of the protein in acellular translation system using one or more radioactively marked amino acids, and studying the protein before extracting and purifying it using methods such as gel-filtration that yield information about the general structural characteristics of the protein. The new testing method showed that the new protein had the desired stable and compact structure and that a theoretically valid method of designing new proteins had been worked out. Figures 8; references 18: 5 Russian, 13 Western.

New Principle for the Organization of Genome Sequences—Long Mirror Sequences of Nucleotides

947C0251 Moscow DOKLADY AKADEMII NAUK in Russian Vol 332 No 2, Sep 93 [manuscript submitted 24 Apr 93] pp 244-250

[Article by N. A. Churikov, Institute of Molecular Biology imeni V. A. Engelgardt, Russian Academy of Sciences, Moscow; UDC 575.85+577.21]

[Abstract] New data are presented indicating the presence in genomes of rather complete mirror duplexes 1200 bp long. The researcher found two pairs of sequences (DmSAT/Dmrg and DmSAT/R2Dm) that have extended mirror sequences of nucleotides and that are located in the same genome. Moreover, mirror sequences corresponding to DmSAT were found in genomes of different organisms. That means that mirror inversions of genome texts are widespread and that extended mirror sequences of nucleotides represent a new type of organization of nucleotide sequences in genomes. The Dmrg, DmSAT, and R2Dm sequences have extended mirror tracts that are involved in the performance of different functions. The mirror sequence R2Dm, for example, is a coding sequence and is symmetrical to the noncoding sequence DmSAT. One can assume that, except for purely genetic advantages, the mirror sequences can have important structural properties It is possible that the mirror genome duplexes are capable of symmetric bending of DNA. That could be important for forming symmetric halves in chromosome DNA superstructures. Figures 4, references 11: 4 Russian, 7 Western.

EPIDEMIOLOGY, MICROBIOLOGY, AND VIROLOGY

Method of Isolating Sequences Missing in One of Two Related Genomes

947C0226A Moscow MOLEKULARNAYA GENETIKA, MIKROBIOLOGIYA I VIRUSOLOGIYA in Russian No 3, May-Jun 93 (manuscript received 25 Jan 93) pp 26-29

[Article by N.A. Lisitsyn, M.V. Rosenberg, G.A. Launer, L.L. Wagner, V.K. Potapov, T.B. Kolesnik, and Ye.D. Sverdlov, Institute of Molecular Genetics and Institute of Bioorganic Chemistry imeni M.M. Shemyakin, Moscow; UDC 616.98.578.812.1]

[Abstract] A new genomic subtraction technique has been developed for isolation of sequences in two related genomes, sequences present in the tracer but absent in the driver. The effectiveness of this technique is demonstrated by the results of a model experiment with bacterial genomes. Driver DNA was taken from the E. coli JM101 strain, purified, and sheared by ultrasonic treatment to an average size of 750 bp, whereupon the LMW (low molecular weight) material weighing less than 300 bp was

removed by gel filtration chromatography on a Sepharose CL-4B column. The remaining 1 mg/ml DNA in water was then mixed with an equal volume of a 2 mg/ml photobiotin acetate in water, whereupon the mixture was placed in a 1 mm wide quartz spectrophotometer cell resting on a TL33 UV Products transilluminator and treated by the latter 10 min long with 365 nm ultraviolet radiation. After this a ten times smaller volume of 1 M pH= 8.9 Tris-HCl was added, whereupon the driver DNA was extracted in three passes with a twice as large volume of saturated aqueous butanol solution, precipitated with ethanol, and dissolved in TE to a 1 mg/ml concentration. Tracer DNA was prepared by adding 5 ng of pTZ18R plasmid DNA to 7 mg of the E. coli JM101 strain and then cleaving it with Sau 3 A restriction endonuclease. The thus digested DNA was combined with 1.7 nmole of 24-mer 5'- and 1.7 mole of 12-mer 5' oligonucleotides in 105 ml of ligase buffer, this mixture then being annealed by slow cooling from 60°C to 4°C in 120 min and subsequently ligated with 10 U of T 4 DNA ligase at 12°C for 15 h. After extraction with phenol/chloroform and subsequent precipitation with ethanol, the tracer DNA was separated by electrophoresis through 2% of fusible Sigma type VII agarose. After removal of the LMW (low molecular weight) material weighing less than 150 bp, the remaining DNA was concentrated in the opposite direction by electrophoresis and then electroeluted from the gel. For hybridization and affinity selection, 0.5 mg of tracer DNA was mixed with 20 mg of driver DNA + 20 mg of yeast tRNA + 10^6 cpm of ^{32}P end-labeled tracer. The was precipitated from this mixture with ethanol and then dissolved in 16 ml of 2.5 xEE buffer. The solution was overlaid with mineral oil and denaturated by heating for 3 min, whereupon 4 ml of 5 M NaCl was added. This mixture was incubated at 64°C for 15-20 h. After hybridization, the biotinylated DNA was extracted from it with streptavidin-phenol/chloroform, then precipitated with ethanol, and dissolved in 110 ml of TE. While a 10 ml sample of the solution was retained for analysis, the remainder was mixed with 20 mg of driver DNA + 5 mg of yeast tRNA and then precipitated with ethanol. Three such hybridization and affinity selection cycles were performed in the experiment. For polymerase chain reaction were used 20 ml of a mixture containing 67 mM Tris-HCl (pH= 8.2 at 25°C) + 2 mM $MgCl_2$ + 16 mM $(NH_4)_2$ + 170 mg/ml of BSA + 200 mM dNTP each + 1 mM 24-mer 5'- primer + 1/20 of total nonextractable DNA, this mixture being incubated for 1 min at 72°C in a Perkin-Elmer/Cetus thermal cycler. With 2 U of Tag polymerase added to fill in the 5' protruding ends, the reaction was incubated for 2 min and then amplified. Each cycle consisted of 30 s at 94°C + 165 s at 72°C, the 34 cycles being followed by an additional extension at 72° for 10 min. Amplified DNA was analyzed by electrophoresis through 2% agarose. Amplification after second and third subtraction cycles was found to reveal only plasmid- derived fragments of 250-1000 bp sizes initially comprising 0.071% of the tracer DNA, this technique thus being a very effective one. It differs from the one described by D. Straus and F.M. Ausubel (U.S. National Academy of Sciences; PROCEEDINGS Vol 87, 1990) in that it includes attachment of special polymerase chain reaction adapters to the tracer prior to hybridization so that only self-annealed double-stranded tracer molecules become amplified, their separation from single-stranded resulting in further enrichment. The authors thank Donald Straus at Brandeis University for making available their genomic subtraction protocol. Their study was supported by a grant from the State Program on Human Genome, with contributions by the NAL and the MVR. Figures 2; references 14.

Russian Scientist Urges Caution With Mad Cow Disease

[VOPROSY VIRUSOLOGII Mar-Apr 94,etc.]

[Editorial Report] E. R. Pille, from the Russian Academy of Medical Sciences' Viral Preparations Institute, recently warned that control measures for bovine spongiform encephalopathy (BSE) may be inadequate (Moscow VOPROSY VIRUSOLOGII Mar-Apr 94). The newly discovered disease, which causes dementia and death in cows, has been diagnosed in tens of thousands of British cattle since 1986, raising international concerns about British beef (Moscow IZVESTIYA 2 Jan 92, 21 Jan 92, PRAVDA 9 Jan 92, All-Union Radio Mayak 6 Jan 92, London FINANCIAL TIMES 29 Mar 94). Present safety measures are based on the belief that the pathogen is unlikely to affect humans or to spread from animal to animal. In contrast, Pille maintained that the BSE pathogen should be treated as highly dangerous to people until more is known about it.

In his article in the Russian Academy of Medical Sciences virology journal, Pille presented evidence that BSE may be hazardous for humans. Scientists believe that British cows contracted BSE by eating feed containing bone meal from sheep sick with scrapie, a BSE-like veterinary disease. Present BSE control strategies assume that since humans do not catch scrapie from sheep, they cannot catch BSE from cows. Pille disagreed. He theorized that the scrapie pathogen could have become more infectious for humans when it adapted to cattle. Pille also noted the suspected linkage of BSE to Creutzfeldt-Jakov disease, a rare, transmissible spongiform encephalopathy of humans that is usually fatal. Long-term epidemiological studies are needed to assess the risks to humans, he said.

Pille also advised against the German practice of permitting sales of beef from healthy cows in BSE-infected herds after removal of the bones, nerves and lymphoid tissue. The Russian scientist thought this procedure may leave BSE pathogen in other tissues, allowing it to contaminate the meat during butchering.

Although existing safety measures assume that the BSE pathogen is transmitted solely through feed, Pille hypothesized that cows may be able to contract the disease from sick cows or contaminated pastures. He also concluded that transplacental transmission could not be ruled out. Pille's analysis was apparently supported by reports of possible transplacental or animal-to-animal BSE transmission in zoo animals (London THE TIMES 13 October 93). A further indication that animal-to-animal transmission may be occurring is the fact that the number of cattle diagnosed with BSE has far exceeded British estimates. This discrepancy casts doubt on the official prediction that

the disease will be eliminated by the end of the decade, as well as on the validity of present control measures (London THE DAILY TELEGRAPH 12 Mar 93).

Interferon Immunomodulation and Typhus Vaccination

947C0371A Moscow ZHURNAL MIKROBIOLOGII, EPIDEMIOLOGII I IMMUNOBIOLOGII in Russian No 5, Sep-Oct 93 (manuscript received 14 Apr 91) pp 65-71

[Article by Yu.N. Malinkin, V.V. Mikhaylov, V.A. Pshenichnov and T.P. Pashanina, Virology Sector, Scientific Research Institute, Ministry of Health, Russian Federation, Moscow Oblast; UDC616.9-092.578.245]-07]

[Abstract] Reports that human leukocyte INF-α can modulate humoral immunity led to an assessment of native and recombinant INF-α in modulating the immune response of experimental animals immunized with typhus vaccine. The experimental approach involved rhesus monkeys, Javanese macaques and guinea pigs immunized subcutaneously with the vaccine and treated with 10^5 IU/kg of INF-α according to various schedules. The essential findings were that native INF-α enhanced the humoral response in rhesus monkeys to primary immunization, but was ineffective in re-immunized macaques. Recombinant INF-α was ineffective in both monkey species on primary immunization, as well as in guinea pigs. Results on the effects of both interferon preparations on cellular immunity in the monkeys were largely equivocal. These observations underscore the animal species factor in testing potential effects of different interferon prepations on the immune system. Tables 3; references 12: 9 Russian, 3 Western.

Modified Polystyrene Planchets in ELISA Diagnosis of Infections

947C0371B Moscow ZHURNAL MIKROBIOLOGII, EPIDEMIOLOGII I IMMUNOBIOLOGII in Russian No 5, Sep-Oct 93 (manuscript received 25 Jun 91) pp 97-100

[Article by A.G. Meshandin, L.I. Vaneyeva, N.P. Agapkina, and T.A. Dargeyeva, Scientific Ressearch Institute of Vaccines and Sera imeni N.I. Mechnikov, Russian Academy of Medical Sciences, Moscow; UDC 616.9-078.33]

[Abstract] A patented modification of polystyrene planchets used in ELISA enhanced several fold their adsorbtive capacity [Meshandin, AG, et al., Authors' Certificate, No 1641093 USSR]. The modified planchets can be used in acid buffers, as well as basic and neutral solutions. ELISAs utilizing the modified planchets have 2- to 10-fold greater sensitivity in the diagnosis of viral hepatitis and HIV infections. In addition, standardization of ELISA tests for AIDS with the use of the modified planchets has the potential of reducing the cost of the tests by 25%. Figures 3; Tables 2; references 2 (Russian).

Differential Prenosologic Characteristics of Rats After Chemical Exposure

947C0374A Moscow GIGIYENA I SANITARIYA in Russian No 4, Apr 94 (manuscript received 14 Feb 94) pp 8-10

[Article by G.F. Semenova, N.N. Belyayeva and T.I. Bonashevskaya, Scientific Research Institutes of Pediatrics and of Human Ecology and Environmental Hygiene imeni A.N. Sysin, Russian Academy of Medical Sciences, Moscow; UDC 614.73-092.9-07]

[Abstract] Outbred albino rats, males and females, were employed in the identification of criteria for preclinical assessment of changes resulting from exposure to air pollutants (nitrogen oxides, formaldehyde, phenol, acetone, styrene, sulfur anhydride). The concentrations employed were those normally prevalent in air as well those exceeding threshold limit values (from < 5X to > 20X). Determination of preclinical damage was predicated on the histologic and histochemical assessment of hepatic and pulmonary tissues, with the former found to be more informative. The highest correlation coefficient indicating group exposure was provided by the expression $K = 0.869 + 0.278E + 0.028IA$ ($r^2 = 0.762$, $n = 11$), where K indicates the group of the animal, E represents distribution of lymphocytes with excessive succinic dehydrogenase activity, and IA is the index of alteration in hepatic histology. Tables 2; references 6 (Russian).

Dynamics of Burn Wound Microflora and Antibiotic Sensitivity

947C0285A Minsk ZDRAVOOKHRANENIYE BELORUSSII in Russian No 2, Feb 94 (manuscript received 03 Sep 93) pp 23-27

[Article by A. P. Krasilnikov, P. I. Bulay, A. A. Adarchenko, I. N. Slabko, Intrahospital Infections Laboratory, Central Research Laboratory, Minsk Medical Institute, Belarus Burn Center; UDC 616- 001.17:576.8.06]

[Abstract] This investigation focused on the role of microorganisms in the development of burn wound infections and their sensitivity to antibiotics. Research revealed that microorganisms were found in 826 of the 865 patients admitted to burn centers between 1972 and 1992. The chief etiological agents of burn wound infection over the past 20 years have been *Staphylococcus aureus*, blue pus bacillus, and *Enterobacteriaceae*, with *S. aureus* taking 71-90.6 percent of the share. While the dynamics for most of the bacteria studied constantly changed, the incidence of coagulase-negative *Staphylococcus* steadily increased from 0.9 in 1972 to 17.0 in 1992. The data also showed that these bacterial strains are becoming resistant to an increasing number of antibiotics. *S. aureus* resistance to oxacillin is especially alarming, because these bacteria are also resistant to cephalosporins and because they can cause hospital outbreaks. The most effective antibiotics have been amikacin, gentamicin, sisomicin, and brulamycin [sic]. Finally, changes in burn treatment methods have also affected the composition of burn wound bacterial flora. The open treatment methods have created less favorable conditions for blue pus bacillus with a resultant decrease in

pseudomonad infections and septic complications. Tables 2; references 8: 6 Russian, 2 Western.

MEDICINE AND PUBLIC HEALTH

Blood Shortage Affects Military and Civilian Alike

[RABOCHAYA TRIBUNA 8 Apr 1994, etc.]

[Editorial Report] Russia is continuing to experience shortages of blood donations, according to recent press articles. RABOCHAYA TRIBUNA (8 Apr 94) reports that only 120,000 Moscovites donated blood this year, compared to 360,000 three years ago, providing 27 tons of blood instead of the 110 formerly received. Moscow medical institutions reportedly get only 60 percent of needed blood supplies. In an effort to reverse the trend, Moscow has opened four new transfusion stations and established transfusion departments at hospitals. The shortage has created a black market for blood from medically unscreened donors who are approached directly by the consumer.

ROSSIYSKAYA GAZETA journalist Sergey Ponomarev (15 Apr 94 p 3) reports that the Russian military is also having problems getting enough blood—not only for soliders but also for veterans, military retirees and family members who have been increasingly required to use the military medical system since the reorganization of public health sector. Unable to provide overall military statistics because they are classified, Ponomarev describes the experience of Okrug Transfusion Station No 78. This facility receives 3 tons of blood per year from 7,500 donors during regular visits to military installations at one to two week intervals.

Reportedly, part of the problem is understaffed military units: conscripts now constitute 50 percent of military donors, down from 98 percent three years ago. Many conscripts who wish to donate are turned away because they have health problems or are underweight. Ponomarev also reports a shortage of funds to pay compensated donors and to buy transfusion supplies.

Insulin Shortage Sparks Panic

[GOLOS 4-10 Apr 1994, etc.]

[Editorial Report] Insulin disappeared from Moscow pharmacy shelves in April 1994, panicking diabetics. The head of the Endocrinology Institute, however, reportedly said that Moscow Oblast diabetics had not yet exhausted existing supplies (Moscow GOLOS 4-10 Apr 94).

The Moscow newspaper GOLOS attributed the shortage to the closing of "a number of pharmaceutical enterprises." Reporter Dmitriy Shramov also alleged that insulin distribution had been commercialized, condemning indigent Russians to "a slow, agonizing death." Shramov also reported that the Health Ministry had not yet reviewed the problem of financing a 184 million dollar program for importing insulin and other medicines for diabetics (GOLOS 4-10 Apr 94).

In a 29 April 94 ROSSIYSKIYE VESTI interview, Tamara Dolgopolova, the deputy head of the Health Ministry's Administration for Supplying Pharmaceuticals and Medical Equipment attempted to reassure the public about the availability of insulin. She denied that the Russian Federation had shut down or converted insulin plants. Instead, she said, Russia had almost completely lost its former ties to insulin factories now located in other independent republics. In her opinion, a Russian law mandating free pharmaceuticals for seriously ill citizens requires the Health Ministry to set up domestic production of insulin.

Dolgopolova also refuted the claim that the distribution of insulin had been commercialized, saying that commercial importers of insulin are compensated by the government. Centralized governmental imports of insulin are also being supplemented by direct purchases by oblast public health departments. Dolgopolova said insulin supply problems were due in part to local officials' failure to submit requirements to central purchase authorities. She also advised diabetics to sue or complain to local authorities when pharmacies refuse them insulin.

Hemosorption System for Extreme Conditions

[POISK 25-31 Mar 1994]

(Editorial Report] POISK (25-31 Mar 94) reports a novel Russian hemosorption system capable of operating under extreme conditions. Because of its unique ability to perform single-catheter hemosorption, the device was used extensively in treating Armenian earthquake victims with limb injuries. Western devices, which use two catheters, were unable to treat these patients. The system also automatically adjusts to blood viscosity, process duration, catheter diameter, catheter position, and the volume of blood in the patient's vein. Its other reported advantages over US, Japanese, German, Italian and Swedish devices include: portability (2-5 kilograms versus 20 to 30 kilograms for foreign devices), better adaptation to the vascular system, and simple, easily adjusted sorption columns. Reportedly, the equipment is the only hemosorption device to indicate the volume of blood purified. Developer Dr. Aleksandr Davydkin received four Soviet and one Russian Federation patents for the equipment, as well as approval from the RF Health Ministry's Committee on New Equipment. The Health Ministry has not allocated funds for mass production of the device despite its reported ability to "compete with the best foreign equipment".

Government Reviews Medical Screening of Conscripts

[ROSSIYSKIYE VESTI, 27 May 1994,etc.]

[Editorial Report] With over a quarter of the draft-age men currently exempted from military service for health reasons, Russia has been having trouble meeting conscription targets (Moscow Radio Rossii Network 22 Jan 94). A draft decree on medical evaluation of military conscripts has been prepared by the Russian Defense Ministry and the Ministry of Health and the Medical Industry (Moscow ROSSIYSKIYE VESTI 27 May 94). ROSSIYSKIYE VESTI reported that the only Health Ministry official to see the document was Minister Eduard Nechayev, who approved it. Representatives of the Committee of Soldiers'

Mothers were unable to confirm rumors that the draft decree will reduce the medical grounds for exemption from military service.

TRUD reported that anxious parents contacted the newspaper after hearing of Defense Minister Grachev's announcement that the multitudinous regulations on medical deferment needed to be revised. In a 17 June TRUD interview, Deputy Director of the Main Military Medicine Administration Yuriy Savvin tried to reassure the public that the defense minister meant only to consolidate two decrees into a single document. Savvin also said that in an effort to screen out unfit recruits, the military was creating permanent military medicine commissions staffed by army doctors to check the work of the rayon recruitment offices' medical commissions.

At a 28 April government conference on this issue, speakers called the existing medical screening system outdated and incapable of reliably identifying unfit conscripts or malingerers. Conference participants resolved to form a working group to draft a plan intended to improve health care and prepare young people for military service. Among conference participants were military medical and conscription officials, as well as representatives of the parliamentary committees for defense and health protection, the interior and education ministries, and the Russian Academy of Medical Sciences (Moscow INTERFAX 28 Apr 94).

Radioactive Contamination of Yamal Peninsula and Assessment of Radioactive Hazard to Population

947C0255A Yekaterinburg EKOLOGIYA in Russian No 4, Jul-Aug 93 pp 39-45

[Article by N.M. Lyubashevskiy, V.I. Starichenko, M.I. Balonov, G.Ya. Bruk, V.N. Shutov, M.G. Nifontova, N.P. Ivanova, N.S. Shvydko, L.N. Basalayeva, Ye.V. Arzhanova, O.F. Sadykov, M.V. Chibiryak and Ye.B. Grigorkina [Plants and Animals Ecology Institute], UrO RAN [Ural Department, Russian Academy of Sciences]; received May 6, 1991; UDC 504.054:621.039.7:504.75.05:621.039.7]

[Abstract] Although territorially the Yamal Peninsula is closer than other regions to the Novaya Zemlya nuclear weapons test site, no radiological studies of the Peninsula had been conducted. This made it necessary to conduct comprehensive studies of radio nuclide content in the environment, in order to assess the effect of technogenic factors and the dose of external and internal radiation of indigenous population and newcomers population on translocation of radio nuclides. The objective of the work was to study the radiological situation in the Yamal Peninsula and assess the current radiation hazard to the health of its population. The comparison of the content of ^{137}Cs and ^{90}Sr in lichens to 1976 and 1980 results published by others demonstrated that over a period of 12 years radio nuclide concentration decreased by approximately 50%. Based on these and other data the authors concluded that the radiological situation in the Yamal Peninsula is typical for the Far North and sub-Arctic regions of Scandinavia and North America. The levels of γ background and external irradiation doses are determined by natural sources and do not exceed average values over the territory of the former USSR. No data indicating additional (besides global) radioactive contamination of the territory had been found. Figures 1, tables 6, references 19: 17 Russian, 2 Western.

Colicinogenic and Adhesive Properties of Enterobacteria Extracted From Water and Other Objects Before and After Chernobyl AES Accident

947C0265 Kiev KHIMIYA I TEKHNOLOGIYA VODY in Russian Vol 15 No 9-10, Sep-Oct 93 pp 683-686

[Article by T.V. Bey and L.V. Grigoryeva (Ukrainian Scientific Hygiene Center, city of Kiev); received Jan 19 1993; UDC 576.809.095:616.981]

[Abstract] Environmental pollution caused by the Chernobyl AES accident directly and indirectly affects human health. The objective of the work was to study biological peculiarities of pathogenic Escherichia (PE) extracted from various objects in Ukraine before and after the accident. Two main features were selected for comparative analysis colicinogenicity and adhesivity. Biological features of 178 PE strains were studied; most of the strains were extracted from water before and after the accident. After entering the environment the strains retained the capability of producing colicines in 35.4% cases. This property was most often observed in strains extracted from potable water and soil. The adhesivity of PE extracted from various environmental objects before the accident varied from 14.1% in waste water to 33.3@12.2% in water reservoirs and soil. On average 24.3% of strains had virulent properties. Adhesivity of cultures in strains extracted after April 1986 decreased insignificantly, which indicates relative stability and conservative character of adhesive properties of PE compared to colicinogenicity. It is concluded that after the Chernobyl AES accident colicynogenic activity of PE extracted from water and other environmental objects in Ukraine has increased considerably. This increases the risk of infestation of humans and animals. Tables 3, references 9: 8 Russian, 1 Western.

Biotechnology of Pretreatment of Dniester Water at Belyayev Water Treatment Plant

947C0265 Kiev KHIMIYA I TEKHNOLOGIYA VODY in Russian Vol 15 No 9-10, Sep-Oct 93 pp 690-696

[Article by L.I. Globa, P.I. Gvozdyak, G.N. Nikovskaya, N.B. Zagornaya, A.S. Shikin, A.S. Malonoga, F.F. Kratofil, O.S. Dolgoter, T.A. Gudoshnikova and L.V. Podmazko-Tu(Colloidal Chemistry and Hydrochemistry Institute imeni A.V. Dumanskiy, AN [Academy of Sciences] of Ukraine, city of Kiev, and Leasing Enterprise "Odesvodokanal", city of Odessa); received Feb 18 93; UDC 628.163]

[Abstract] The river of Dniester is the only centralized source of potable water for the city of Odessa. At present it is heavily contaminated and does not meet sanitary standards, and degree of its contamination keeps increasing. Effectiveness of the traditional water treatment technology is insufficient. Additional water treatment using carbon or mineral sorbents and ozone cannot be used in Odessa in the foreseeable future due to economic, energy, scientific,

resource, technological and other limitations. The authors contend that biotechnology being developed at the Colloidal Chemistry and Hydrochemistry Institute imeni A.V. Dumanskiy, AN of Ukraine, which intensifies self-purification of natural waters, is the most reasonable economically, ecologically the cleanest and the most effective hygienically. The technology was tested at the "Dnestr" water treatment plant. The technology effectiveness had been studied for one year. It was determined that quality parameters of Dniester water after pretreatment in a bioreactor had improved. The technology is efficient at all seasons. It is suggested that for the next 10 years there is no ecologically and economically feasible alternative to biotechnological pretreatment of Dniester water using the above technology. Figures 3, tables 3, references 16: 12 Russian, 4 Western.

Study of Macroalgae *Chordaria flagelliformis* (Mull.) AG and Rhodomela larix (Turn.) C. AG. Used for Monitoring Heavy Metals in the Gulf of Peter the Great in the Sea of Japan

947C0252B Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: BIOLOGIYA in Russian No 2, Apr-Jun 93 [manuscript submitted 10 Dec 92] pp 18-25

[Article by Ye. Yu. Zolotukhina, N. V. Radzinskaya, I. V. Tropin, Ye. Ye. Gavrilenko (deceased); UDC 581.526]

[Abstract] Macroalgae are almost ideal as organisms used for monitoring heavy metals in coastal maritime areas. One of the most valuable qualities of macrophytes is their high concentrating ability for such elements, which makes it possible to avoid the use of unwieldy techniques for concentrating large volumes of seawater that require special reagents. Fucus algae have been proposed for monitoring the metals in the coastal waters of the far-eastern seas of Russia. Perennial fucoids offer distinct advantages over seasonal macrophytes in that they enable expansion of the time periods in which the monitoring can take place. For many metals, however, the accumulating capability of fucoids is inferior to that of a whole array of brown and red algae that are just as widespread and accessible. As a result of lengthy research in the Gulf of Peter the Great, *Rhodomela larix* and *Chordaria flagelliformis* have been identified as effective metal concentrators. *Rhodomela larix* is best used for CR, Fe, Cu, and Zn, whereas *Chordaria flagelliformis* is best used for Cd and Mn. Both, used in conjunction, are appropriate for Ni and Pb. Figures 2, references 8 (Russian).

Life Sciences Innovations

[NEZAVISIMAYA GAZETA 9 Jun 1994, etc.]

Environment

[Editorial Report] A 7 June session of the Interdepartmental Commission of the Security Council on Health Protection discussed the possibility of processing medical and biological wastes using plasma technology patented by the Plasma-Test Joint Stock Company. The firm claims that its method of high- pressure, high-temperature combustion guarantees "absolute epidemiological and ecological safety," providing products that can be reused industrially. Government experts called the technology highly effective and proposed funding the technology under a federal program on wastes (Moscow NEZAVISIMAYA GAZETA 9 Jun 94).

The recently declassified laboratories of the Tensor plant in Dubna have developed the FB-2 "superfilter," claimed to be the world's most effective filter. Also known as the "Kristallik," the novel multilayer filter is made from thin polymer film saturated with isotopes. A faucet-mounted version cleanses tap water, with a color change signaling depletion of the filter element. The device, which was developed through computer modelling, is protected by two dozen Russian patents. (Moscow RABOCHAYA TRIBUNA 15 Jun 94)

New Pharmaceuticals

Piktomalon, a new nootropic and vascular drug, has passed clinical tests. The pharmaceutical is used to treat disorders of the cerebral blood circulation, alcoholism, vascular dystonia, anxiety, fear and irritability. It also increases resistance to physical and mental stress (ROSSIYSKIYE VESTI 29 Apr 94).

A new Russian pharmaceutical, Izonidez, prevents and treats postoperative adhesions when sprayed into the abdominal cavity following surgery. It has the unique advantage of not interfering with fibrin deposition and postoperative wound healing (ROSSIYSKIYE VESTI 3 Jun 94).

Legalon, a new hepatoprotector derived from the milk thistle Silybum marianum (L.) Gaertn., improves and restores liver function and increases the organ's resistance to pathological influences (ROSSIYSKIYE VESTI 6 May 94).

Soon to be offered for sale is Sinepress, a new preparation for treating hypertension (ROSSIYSKIYE VESTI 27 May 94).

The Moscow Cardiology Center has completed testing of a new pharmaceutical for treating head trauma and cerebral vascular disorders such as strokes. Nitsergolin also has a spasmolytic effect (ROSSIYSKIYE VESTI 10 Jun 94).

The German production association Herbstreyt & Fox and Moscow State Academy of Food Products have jointly developed Medetopekt, a preparation that promotes elimination of heavy metal ions and radionuclides from the body. Tests at the Russian Health Ministry's Biophysics Institute, the Russian Academy of Medical Sciences Nutrition Institute, and the Urals Radiation Medicine Center showed that Medetopekt removes strontium-980 from the body and strengthens immunity. The preparation can also be used to protect workers exposed to heavy metals and to treat atherosclerosis, obesity and diabetes. Medetopekt tablets are being offered for sale in Moscow pharmacies (Moscow ROSSIYSKIYE VESTI 27 May 94).

Medicine

The Military Medical Academy is seeking funding in order to teach other clinics its novel burn treatments, now used exclusively at the Academy, the Vishnevskiy Institute of Surgery and the Sklifosovskiy Emergency Medicine Institute. The new therapies include a donor skin preservative

which also reduces blood losses by 25 to 30 percent. The academy has also developed a method of microdermoplasty consisting of mincing the patient's surviving skin, placing fragments on the wound at 10-15 mm intervals and covering them with donor skin. A third technique makes it possible to obtain 1 square meter of skin by culturing skin cells from fragments as small as 1 square cm in area (Moscow IZVESTIYA 1 Feb 94).

Russian scientists have developed laser therapy for destructive tuberculosis of the lungs that reportedly cures 75 percent of patients and improves the condition of 90 percent. Using the Almitsin nitrogen laser developed by the General Physics Institute and a needle containing a light guide, the researchers treated pulmonary lesions with ultraviolet laser radiation for 10-15 min. Clinical tests were conducted in Moscow, Tashkent, and India (Moscow GOLOS 4-10 Apr 94).

Physicians at the Moscow Center for Joint Endoprosthetics have developed an artificial hip joint that lasts longer because it is lubricated by droplets of marrow. (Moscow ROSSIYSKIYE VESTI 27 May 94).

Medical Equipment

The Integrated Medicine Center claims development of a computerized system that analyzes "12 functional systems" of patients from data obtained by placing a sensor on the patient's wrist (Moscow DELOVOY MIR 3 Jun 94).

A novel laser "perforator," the "ERMED-303," has been developed by the Engineering Center for New Technologies of the Russian Academmy of Sciences' Nuclear Research Institute jointly with the "Lasers and Apparatus" scientific production center. The device, which has no foreign analogues, injects medicines with the aid of a narrow, directed laser beam. In clinical tests at major Russian medical institutions, the device ensured sterile and practically painfree injections. The engineering center has a production capacity of 60 units a month at a price of 120 to 150 thousand rubles each. (KOMMERSANT-DAILY 29 Jan 93).

Nutritional Assessment of Students in Altay Kray

947C0374B Moscow GIGIYENA I SANITARIYA in Russian No 4, Apr 94 (manuscript received 10 Dec 93) pp 32-34

[Article by A.V. Istomin and L.A. Rumyantseva, Moscow Scientific Research Institute imeni F.F. Erisman; UDC 613.2-053.5(571.15)]

[Abstract] Questionnaire surveys on 530 children, 6 to 17 years old, were employed as part of a nutrition survey in the Altay Kray. The students were required to describe the previous day's diet on two occasions. The data revealed that the school diets were rich in carbohydrates but poor in proteins, including those derived from animal sources, deficient in vitamins A and C, as well as in calcium, phosphorus and iodine. On the basis of the findings appropriate recommendations were made for improvements in school and home diets to enhance the nutritional status of children in Altay Kray. Tables 4; references 10 (Russian).

Energy Expenditures, Work Conditions and Nutritional Status of Workers at Deep Arctic Mines

947C0374C Moscow GIGIYENA I SANITARIYA in Russian No 4, Apr 94 (manuscript received 13 Jan 94) pp 34-36

[Article by T.K. Tatyanyuk and A.V. Istomin, Moscow Scientific Research Institute of Hygiene imeni F.F. Erisman; UDC616-057-092:612.013.7]-02:613.693/.664]-07]

[Abstract] Nutritional assessment and energy balance studies were performed on 20 clinically healthy miners employed at the Oktyabrskiy mine in Norilsk. The cohort ranged in age from 25 to 39 years with a work history in the region of over 5 years at depths approaching 1000 m. The various occupational groups presented with an average energy expenditure of 2286 kcal/shift and 1885 kcal during nonshift hours which, with 10% added for indeterminate expenditures, came to 4590 kcal/day. The major source of food for the miners was provided by the mine cafeteria. The diet was found to be inadequate for the Arctic miners, providing only 66% of the recommended daily intake of proteins, 61% of fats, 71% of carbohydrates and 67% of the calories. Deficiencies were also noted in the vitamin and mineral content. Accordingly, recommendations were made to improve the nutritional status of the Arctic miners and, thereby, their work performance. Tables 3; references 12 (Russian).

Food Services in Areas Affected by Chernobyl Fallout

947C0374D Moscow GIGIYENA I SANITARIYA in Russian No 4, Apr 94 (manuscript received 20 Jan 94) pp 37-38

[Article by A.V. Istomin, Moscow Scientific Research Institute of Hygiene imeni F.F. Erisman; UDC613.2-02:614.876]-07]

[Abstract] Food services utilized by 5,000 workers in the Plavskiy Rayon, Tula Oblast were monitored as part of a nutritional survey in an area subjected to Chernobyl fallout (5-15 Ci/km^2). The findings revealed that the energy value of the menus ranged from 746 to 1077 kcal/day, corresponding to 28 and 37% of the daily energy requirements of men and women, respectively. In addition, the diets provided only 62% of the recommened daily vitamin intake, and were also deficient in calcium, phosphorus, magnesium, iron, and iodine. The food services were advised to provide balanced meals in accordance with the nutritional guidelines established by the Institute of Nutrition of the Russian Academy of Medical Sciences and the Institute of Biophysics of the Russian Ministry of Health. In addition, the workers are being encouraged to drink mineral waters and take multivitamin capsures. Figures 1; tables 1; references 8 (Russian).

Energy Reguirements of Adolescent Tractor-Driver Trainees in Uzbekistan

947C0374E Moscow GIGIYENA I SANITARIYA in Russian No 4, Apr 94 (manuscript received 20 Dec 93) pp 54-55

[Article by G.O. Igamberdyyeva, N.S. Abramova and N.V. Voronina, Scientific Research Institute of Sanitation, Hygiene and Occupational Diseases, Ministry of Health, Tashkent, Uzbekistan; UDC613.644-07:572.51]-053.67]

[Abstract] General health and nutritional assessment of 240 adolescent tractor-driver trainees in Uzbekistan demonstrated that their caloric requirements came to 3040 kcal/day on days devoted to classroom activities and 3200 kcal/day during field practice. The average intake, however, was on the order of 2943.2 kcal/day. The usual diets were also deficient in vitamins and minerals. In terms of physical development 69.8% of the trainees were reported as normal, 16.3% below normal and 13.9% above average. Most also presented with evidence of moderately impaired hepatic protein synthesis. These observations were incorporated in setting nutritional standards for this class of students in Uzbekistan. Tables 1; references 8 (Russian).

Vaccine Program Considered

[ROSSIYSKIYE VESTIY 15 Apr 1994]

[Editorial Report] The State Duma Committee on Health Protection recently reviewed a 15 billion ruble federal program "Vaccine Prophylaxis" presented by the State Oversight Committee on Health and Epidemiology. Program objectives are to eliminate poliomyelitis by the year 2000, eliminate diphtheria deaths by 1995, and reduce the incidence of whooping cough and measles to 5 and 3 cases per 100,000 population, respectively, by 1997. An additional goal is a high vaccination rate for children. The program plans to modernize Russia's seven vaccine manufacturers, solve vaccine storage and transportation problems, improve compilation of epidemiological statistics, and organize regional training centers for medical personnel (Moscow ROSSIYSKIYE VESTI 15 Apr 94).

Russian Trade Organizations Refuse Shipments of Medical Equipment Spare Parts

[TRUD 20 Apr 1994]

[Editorial Report] Russian trade associations have been refusing shipments of medical equipment spare parts which were ordered using International Reconstruction and Development Bank credits. At stake are over 30 contracts worth over 12 million dollars at deeply discounted prices. The parts are needed to repair Russia's imported medical equipment, reportedly worth over 3 billion dollars (Moscow TRUD 30 Apr 94).

TRUD reporter Nikolay Gogol attributes the unexpected response to trade organizations' reluctance to bear the risk of accepting the items for medical institutions, which often lack purchase funds. In April 1994, the Russian Ministry of Public Health sent letters to regional authorities urging them to help medical institutions purchase scarce medical equipment parts and supplies. Local authorities in Omsk, Chelyabinsk, Yekaterinburg and Krasnodar had already taken this action independently.

Public Health Watch

[ROSSIYSKIYE VESTI 28 Apr 94, etc.]

Draft Statute Limits Medical Industry Privatization

[Editorial Report] On 12 April the Ministry of Public Health and the Medical Industry presented the State Duma Committee on Health Protection with a draft interim statute that "significantly expands" the list of medical organizations not subject to privatization. A ROSSIYSKIYE VESTI report (28 Apr 94) characterizes the move as a violation of Presidential Edict No 2284 (24 Dec 93) "On the State Program for Privatizing State and Municipal Enterprises in the Russian Federation." Edict 2284 required the Russian Federation Government to prepare a draft law "On Privatization of Public Health Institutions, Pharmaceutical Institutions and Enterprises" by 1 March 1994. Reporter Galina Yudkevich said that by writing a statute rather than a law the ministry was ensuring that privatization measures would be enacted not by Parliament but by "bureaucrats whom privatization will deprive of part of their property." A paragraph of the draft reportedly deals with "other public health institutions, organizations and enterprises, which the RF Government forbids to be privatized." Institutes Seek Royalties

Heads of leading chemical and pharmaceutical institutes told the State Duma Commitee on Health Protection that their organizations face imminent collapse unless a mechanism can be established to give them a share of profits from production of the drugs they develop. Committee chairman Bela Denisenko has created a joint expert group consisting of committee members and pharmaceutical institute directors. The group will propose budgetary allocations for the institutes. They reportedly will also attempt to account for the 4.8 billion rubles allocated to development of pharmaceutical science in 1993 (Moscow ROSSIYSKIYE VESTI 29 Apr 94). Minister Slights Workplace Health Conference

The Health Ministry reputedly sent no representatives to a conference on workplace health. ROSSIYSKIYE VESTI reporter Tatyana Sadkovskaya quoted "initiates" who attributed the lack of Health Ministry participation to rivalry between Health Minister Eduard Nechayev and conference organizer Aleksandr Razumov (10 Jun 94).

Scabies Incidence Rises Rapidly

947C0269A Moscow MOSKOVSKAYA PRAVDA in Russian No Unknown, 27 Nov 93 p 9

[Excerpts from article by L. Kryuchkova, K. Moshkov, 'This is the Last Thing we Need']

[Text] One more "flower" was added to the "bouquet" of infectious diseases which are increasingly worrying the medical experts—scabies. Every day, the illness long known in the capital reminds of its presence. Its etiological agent—the scabies mite or tick—has a free run in the corridors of power.

But this has nothing to do with the living conditions especially favorable for the parasite. In recent years, a persistent trend has been observed toward an increase in all infectious diseases related to the plummeting cultural level of the city's population.

An increase in the scabies morbidity has been observed in Moscow since 1990. It peaked in 1992—when compared to 1991, it rose by 250%. During just nine months of this year, 7,987 persons fell ill, which is almost twice as much as during the same period of the last year.

Self-treatment against scabies leads to serious complications, primarily to the development of severe dermatitis. Realistically, only one remedy is capable of helping against this disease—benzyl benzoate. This preparation is sold by prescription in pharmacies. Yet pharmaceutical plants have not been able to restructure and adjust to this increase in morbidity, while the level of its production rose insignificantly. The minimum price for one flask in the "black" market is 2,000 rubles yet no one can guarantee that the label matches the contents.

The most important in this situation is not only to start the treatment on time but always to observe basic principles of personal hygiene.

Health Minister Notes Improvement of Health Indicators

947C0273A Moscow NEZAVISIMAYA GAZETA in Russian 17 Mar 94 p 2

[Brief "Postfactum," Moscow]

[Text] The Russian minister of health and the medical industry, Eduard Nechayev, believes it necessary to retain in our country a state health care system, with free and accessible medical care guaranteed by the Constitution for all Russian citizens. "This is the position of the Russian Ministry of Health," he declared. As stated by the minister, a full-scale reform of public health began in 1993 and "positive changes are already evident." He noted that, as compared to 1992, maternal mortality (during childbirth) has decreased by one-third, there has been a 25 percent decrease in number of abortions and 20 percent decrease in deaths due to myocardial infarction.

WHO Study Shows East European Women's Health Lags Behind West

947C0273B Moscow RABOCHAYA TRIBUNA in Russian 6 Mar 94 p 1

[Article by Aleksandr Sorokin (RABOCHAYA TRIBUNA correspondent), Brussels: "Maybe WHO Will Help"]

[Text]It is difficult to refer to the study carried out by the World Health Organization (WHO), with the collaboration of specialists from 11 East European countries as anything but an alarm. The attention of physicians was been concentrated on evaluation of health status of more than 200 million women in Russia and other former Soviet republics, as well as some nations of Central and Eastern Europe.

According to this study, there has been significant growth in the rift between Western and Eastern Europe with respect to an indictor such as mean life expectancy of women, and at the present time it constitutes 5 years. In some of the former Soviet republics this rift is even greater. For example, in Turkmenistan. There, women live to the age of 70 years, whereas life expectancy in Western Europe is 79.9 years.

There has been a considerable increase in recent years, in nations undergoing reform, in incidence of cardiovascular diseases among women, related to smoking and drinking. There has been a rise in mortality due to cancer, which results from late diagnosis of diseases or mistakes in treatment.

Poor nutrition and lack of hygiene is another consequences of advancing poverty. In particular, for many residents of Moscow, the daily diet consists of potatoes and onions, in addition to bread.

WHO is sounding the alarm as well because of working conditions for women in East European countries. Forty-eight percent of the weaker sex are employed in industry. Night shifts and work in hazardous industries are not prohibited by legislation, and women are thus employed on a broad scale. However, women receive only one-third of men's wages for equivalent work in 44 percent of the cases examined.

The main victims of poverty are elderly women who receive virtually no public assistance. Young single women and single female parents are in a difficult situation. Many of them are compelled to work as prostitutes in order to survive. Expressly they are trapped in the nets of underground transporters of "live merchandise" to the West.

In view of the existing situation, WHO intends to prepare specific aid programs for each country.

Hospitals Obtain Licenses

947C0273C Moscow MOSKOVSKAYA PRAVDA in Russian 23 Nov 93 p 9

[Article under the rubric "Licensing.: If You Are Sick, Get Treatment"]

[Text]We remind you that you should seek help only in medical institutions that have the right to give it. And this right is confirmed by a document, a license.

The following have been licensed:

Municipal polyclinics Nos 90, 74, 10, 84, 88, 106, 221, 11, 49, 150, 135, 60; municipal pediatric polyclinics Nos. 80, 63, 97, 56, 46, 134, 69, 62; clinics for tuberculosis patients Nos. 4, 15; municipal stomatological polyclinic No 48 (municipal enterprise); medical and physical culture clinic No 25; dermatovenereological clinic No 23 (municipal enterprise) of the South-West Administrative Okrug;

Municipal pediatric polyclinics Nos 135, 61, 114 (municipal enterprises); municipal polyclinic No 187, polyclinic No 133 (municipal enterprise), neuropsychiatric clinic No 10; dermatovenereological clinics No 21, 12; stomatological polyclinic No 27; medical sections Nos 5, 21; child centers Nos. 14, 20; medical and physical culture clinic No 15 of the South-East Administrative Okrug;

Municipal pediatric polyclinics Nos 26, 125; municipal stomatological polyclinic No 20; medical sections No 64, 67; women's consultation office No 18; child center No 8; neuropsychiatric clinic No 19; dermatovenereological clinics Nos 20, 8; substance abuse clinic No 13 in the North-East Administrative Okrug.

'We shall continue to publish the list of medical institutions that have been licensed in the next issue.

Virology Institute Conducts AIDS Research

947C0273D Moscow SELSKAYA ZHIZN in Russian 30 Nov 93 p 5

[Article by Anatoliy Urvantsev: "Mysteries of the Plague of the 20th Century—1 December Is International AIDS Control Day"]

[Text] The AIDS virus, the plague of the 20th century, is stored in a solid concrete unit reliably isolated from the outside world. Physicians have studied the enemy's face well, but cannot palpate its weak points in order to strike a fatal blow. I touch the knob of the door to the unit where the insidious and thus far unvanquished virus is confined....

I observe with unconcealed interest Anna Tkachenko, candidate of medical sciences, who is disappearing behind the thick door to the unit; she is headed into the den of the beast that has already destroyed many thousands of human lives on our planet.... I cannot enter the unit. Only two members out of the entire staff of the laboratory of genetics of lentiviruses, Research Institute of Viral Preparations, have permission to enter; they have passed through the policy commission.

There, behind the thick walls, the dangerous virus is being cultivated in intricate flasks, with the use of instruments. And the technology is such that it cannot escape to freedom. The scientists who are working with it are clad in protective gear.

"The unit is entirely self-contained," I am told by the chief of the lentivirus genetics laboratory, Sergey Alekseyev, doctor of biological sciences. "Sterility is maintained there, and it has a certificate from the World Health Organization. We are studying the genetics of lentiviruses. The human immunodeficiency virus belongs expressly to this group. We are searching for the most effective agents to suppress reproduction of the virus."

And how does this look in actuality? In this unit, the scientists infect live cells with the AIDS virus, then add substances that lower viral activity. After this, work with proteins is carried out in an open laboratory.

I watch the screen of an electron microscope showing the image of an infected human cell. The insidious virus penetrated into its membrane like the fangs of a snake. The virus growls in response to the injected chemical then stops reacting to it at all.... Scientists must find out how the virus reacts to a drug, how it overcomes its barriers.

It is important for specialists to learn the complex mechanism of viral action, how it settles in cells, what it fears, which barriers it overcomes rapidly and which ones it does not. Virus-specific enzymes read its genes, but only in reverse, rather than direct, order.

Dmitriy Moshkov, senior scientific associate, explains: "It is very important to find the genes of this virus that could be blocked by chemical or biological agents. We do this by means of computer analysis. These are primarily theoretical calculations. And a test of several chemical compounds enables us to study the fine mechanism of action of HIV in living cells. But this does not mean that some chemical that we inject in a cell will necessarily disarm the virus. These are primarily theoretical studies that which many laboratories in the world are conducting."

All of the theoretical information is stored in a computer. Without the latter it would be impossible to come closer to the mystery of survival and insusceptibility of the virus.

There are, however, very many ideas about how to harness this terrible disease. For example, one of them is to block a fragment of viral protein and thereby bar its way into healthy cells. There are quite a few legends, conjectures, and official theories about AIDS and its supposedly still concealed capabilities.

Here is one of them. At the 7th International AIDS Conference, the statement of the scientist Hazeltine to the effect that he has theoretical proof of the possibility of viral transmission in saliva when kissing prompted much concern in the audience.... The virus penetrated into the body through so-called dendrocytes situated on the surface of the mucous membrane of the throat. These cells are a variant of white blood corpuscles, and they readily become prey to the virus which feels free and easy in them and multiplies rapidly, and then starts to penetrate into the human body.

I asked Sergey Borisovich about this:

"We do not have information that has been experimentally confirmed."

The opinion has also been voiced that AIDS existed hundreds of years ago. It is simply that the environment was not so polluted then....

"Indeed, there are many such hypotheses," answers the scientist. "The only thing I could say with certainty is that AIDS was discovered and registered in 1980. As an example, they also say that this disease came to us from outer space. There are also no grounds for such statements. Of course, one could create an exquisite theory on this basis, but no one can tell to what extent it would be close to the truth."

As for the danger of spread of this terrible disease in our country, the specialists in the laboratory expressed serious concern. In their opinion, if AIDS invades colonies, other places of confinement, as well as the army, there could be an enormous number of victims. Thank God, the situation is still being controlled there.

The laboratory of lentivirus genetics is young, it has been in existence for only one year. And it consists of 11 people. They are physicians, chemists, and biologists. They work comprehensively, and for this reason the team was selected on the principle of expediency. In the opinion of Sergey Alekseyev, it is too soon to report any concrete results from the laboratory team's work, theoretical data are being gathered.

There is a rattle of glass tubes and flasks in the laboratory rooms. They have modern domestic and foreign equipment: spectrophotometer, instruments for protein separation. And they have the same problems as many other scientific teams: shortage of resources to acquire spare parts, base materials, poor funding of research projects. However, many billions are allocated in other countries for such research.

But the scientific staff of the laboratory, and even of the entire Research Institute of Viral Preparations, have, I imagine, one advantage—their scientific curiosity and faithfulness to ideas. A whole century was required to

suppress smallpox, and the former laboratory head, Professor S. Marennikova, devoted much effort to this cause; so will AIDS also be rendered harmless, at any rate this is what the new laboratory head, Sergey Alekseyev, and his colleagues believe, and are working toward this difficult victory.

Azerbaijan Continues Ban on Snake Venom Exports

947C0275A Moscow RABOCHAYA TRIBUNA in Russian No Unknown, Feb 94 p 4

[Article by A. Naibov, Baku, 'Venomous Charity Begins at Home']

[Text] The store shelves of the Scientific Production Association of Pharmacology and Folk Medicine at the Azerbaijani Ministry of Public Health are "stuffed" with the most valuable raw material for making drugs—the venom of the gyurza snake. And altho ,gh by shipping standards the poisonous "treasure" is small—only 17 kg—it is very expensive: one can get 15 million dollars in the world market even at dumping prices.

Yet, as people say, venomous charity begins at home: for the fourth year, the product secreted by the gyurza snake does not leave the republic. At first this, "veto" on its exports was imposed by the former popular front authorities paranoid about the "wholesale robbery of the treasures of Azerbaijan." Today, the present authorities are not rushing to open the export gates.

This delights the smugglers, some of whom manage illegally to export more than 1 kg of the poisonous cargo like, e.g., one enterprising visitor detained the year before last at the Ben-Gurion Tel-Aviv Airport.

Yet even the minimum foreign currency proceeds from the sale of the snake venom is comparable to the total foreign currency reserves at the republic.

New Pharmaceutical Plant Sells to Entire Republic

947C0271A Moscow RABOCHAYA TRIBUNA in Russian No Unknown, 26 Jan 94 p 3

[Article by ITAR-TASS, 'Pharmaceutical Plant in the Morning, Drugs in the Evening']

[Text] The pharmaceutical plant which was recently built in the maritime city of Partizansk is experiencing a revival. While one year ago its drug production was known only in the far eastern and Siberian regions of the country, today it is being shipped to all republics, krays, and oblasts of the Russian Federation.

Komsomolsk-na-Amure Acquires American Dental Equipment

947C0271B Moscow RABOCHAYA TRIBUNA in Russian No Unknown, 26 Jan 94 p 3

[Article by ITAR-TASS, 'Let us See Whether American Filling Will Fit Komsomolsk Teeth']

[Text] The doctors from the Pediatric Stomatological Clinic in Komsomolsk-na-Amure are able now to minimize the pain when assisting young patients. Five American dental systems are being installed here; in addition, American-made color-hardening materials have been acquired.

In the words of the chief city dentist Viktor Marchenko, "We decided not to share the imported equipment and materials among all clinics but gave it to the pediatric treatment facility. The concern about the young generation remains our priority. Our dentists must master the new medical procedures. Each unit should be serviced by a group of dentists with various specializations under the guidance of a top-skilled physician. Dentists from Komsomolsk-na-Amure are being sent to the Unit :d States for training."

Statistics on Russian Abortion Rate, Teen Births

947C0271C Moscow RABOCHAYA TRIBUNA in Russian No Unknown, 5 Feb 94 p 4

[Article by Editorial board, 'Bare Figures']

[Text] Four million abortions are performed annually in Russia. On average, each woman has four-to-five abortions. These are the highest indicators in the world.

Fifteen percent of married couples in Russia are childless. The principal reasons are termination of the first pregnancy among women and consequences of venereal diseases among men.

Among the mothers who gave birth at an age of 15-17 in St. Petersburg, almost each became sexually active at 14. Every fifth one had three to five sexual partners before giving birth.

Annually, approximately 190,000 women terminate their first pregnancy, of which 40,000 do so at the age of under 17.

Each fourth schoolgirl age 15 to 17 had sexual contacts. In vocational schools, this figure is even higher—65% among young women and 85% among young men.

Activity of Supervising and Analytical Service of 'Pharmacia' System

947C0285D Minsk ZDRAVOOKHRANENIYE BELORUSSII in Russian No 2, Feb 94 (manuscript received 25 Aug 93) pp 35-37

[Article by V. F. Gorenkov, G. S. Ospanova, I. S. Novik, Belorussian Advanced Physician Training Institute, Belarus Supervising and Analytical Laboratory; UDC 615.012/.014]

[Abstract] This article reports the results of study of the equipment base of the supervising and analytical laboratories, specialists employed, and quality of drugs manufactured for 1990-1992 in Belarus. The supervising and analytical laboratories serve 512 urban and 579 rural pharmacies, and over 1000 other pharmacy offices. The results of this investigation indicate an increase in the quantity of unacceptable pharmaceuticals being produced.

Most errors are attributed to careless measuring of powders and lack of prescribed ingredients. The causes for this are low staffing with experienced pharmacists, poor work organization, and poor intrapharmacy quality control. In addition, over 85 percent of the supervising and analytical laboratories are too small for the amount of work performed. Furthermore, the temperature, humidity, and light are not maintained at appropriate levels, which affects the health of laboratory employees. Suggestions for increasing the quality of pharmaceutical manufacture include: increasing the qualifications of supervisors, equipping the laboratories with modern appliances and equipment, and increasing personal responsibility for drug manufacture and quality. Tables 2; references 3 (Russian).

Interview With Lt. Gen. Ivan Chizh, Chief of Defense Ministry's Main Military Medical Directorate

947C0264A Moscow KRASNAYA ZVEZDA in Russian 3 Feb 94 pp 1-2

[Interview with Lieutenant General Ivan Chizh, chief of the Defense Ministry's Main Military Medical Directorate, by KRASNAYA ZVEZDA correspondent Petr Altunin under the "Interviewee of the Day" rubric: "I Wish the Armed Forces Health"]

[Text] [Boxed item: Business Card: Chizh, Ivan Mikhaylovich. Born in 1949 in the village of Shilinok in the Berezovskiy Rayon of the Brest Oblast. In 1972, he graduated from the military medicine department of Kuybyshev Medical Institute, and in 1981, he graduated from the management department of the Military Medical Academy. Since 1987 he has been chief of the medical service of the Turkestan Military District. In 1991 he was appointed first deputy chief, and in October 1993 he was appointed chief of the Main Military Medical Directorate of the Ministry of Defense. He is chief of the medical service of the Russian Federation Armed Forces and a lieutenant general of the medical service.

He is married and has a son who attends the Military Medical Academy and a daughter who is a college student.]

[Altunin] Ivan Mikhaylovich, for more than 2 years you were the second-ranking figure and are now the top-ranking figure at the Armed Forces' medical service. You represent the current profile of our health care, and what is more, you are well acquainted with the situation regarding medical care in the army and navy. Are the habitual press statements to the effect that the nation's health is, as they say, deteriorating fair?

[Chizh] As far as the country's health is concerned, the lowering of the population's material standard of living, above all the deterioration of the quality of food and the lack of social protection of large groups of people in general and especially retirees and invalids in particular, has had many negative consequences that are reported in the press.

In the army and navy, it must be said, the medical indicators with respect to all key parameters are, comparatively, not bad. Thanks to the discipline and organization of their personnel and the high qualifications and devotion to duty of military physicians in the units and on ships, active and persistent counterepidemic measures are being taken, and living conditions in the army are being strictly controlled.

[Altunin] Tell us, are their enough forces for this? Has the reduction in the Armed Forces affected you?

[Chizh] The overall situation is of course complicated, and it is affecting the state of military medicine. But the law "Concerning the Status of Military Personnel" and subsequent orders of the Defense Ministry raising it to a qualitatively new stage in the Armed Forces have been accompanied not by a reduction in personnel but rather by a strengthening of our institutions.

But how were things prior to this? "Active" military personnel as well as generals and senior officers in the reserves and retirees who had served in the army for 25 years were under our medical care. Now contractees and their families, as well as reserve and retired officers, including junior officers discharged from duty after 20 year or more and their family members, have been added to the aforementioned. If one counts the women and children in garrisons and the workers and employees that we also service, this adds up to about 5 million persons. Imagine, the demand for medical personnel today!

[Altunin] What, in your view, are the reasons for this?

[Chizh] There are several: Above all, there is the uncertainty of everyday life that affects all officers, and for military physicians and especially for the rare specialists, there is the seduction of becoming established in commercial structures....And the number of those wishing to continue training in military medical departments has decreased significantly in the past few years.

[Altunin] And what are you doing about it?

[Chizh] It must be said that the pack of military laws that have recently been passed and have raised the prestige of military service somewhat have had their effect. But we too are doing a thing or two. A system for postgraduate training of physicians has been created that includes primary specialization and systematic advanced training of medical personnel. In addition, a significant number of physicians have the opportunity to receive training in the management department and in clinical studies.

Furthermore, the departments have successfully begun admitting women. At the present time, about 5 percent of all officers and medical personnel are female, and according to forecasts, by the year 2000, 10-15 percent will be female. The enlistment of reserve medical service officers on a contract basis began last year.

[Altunin] Let us say that the personnel matter has been solved. So where are they to service the doubled contingent of patients—these 5 million people? For indeed, the walls of the hospitals and polyclinics are not spreading apart, and new ones are not being built.

[Chizh] No, and why not? New hospital buildings are being built, albeit slowly, and their ultimate overall capacity will increase. Furthermore, we are actively working to expand and reconstruct old and so-called adapted buildings. A

territorial system of medical care for troops has also been created: We are uniting different types of small institutions and different kinds of troops located near one another into base hospitals and polyclinics.

The hospitals include specialized departments and offices, including vascular surgery, oncology, endoscopy, "artificial kidney," ultrasound studies, and others.

As an example, we can cite the No 45 Central Polyclinic of the Moscow Oblast. It contains 18 diagnostic and treatment departments, 12 offices, and an infectious immunology laboratory. About 30,000 patients received consultations here last year. Many of them were given the necessary care by different modern examination methods at time of admission. Day hospitals have become a new and undoubtedly progressive form of operation for military polyclinics. What is that? When first received by a physician-therapist or surgeon, an officer is directed to that polyclinic hospital where, without altering his "way of life," he will undergo a complete examination by all the specialists concerned with his ailment. The patients who have gone through "day hospitals" during the past 3 years could not have been accommodated at a 300-cot hospital. And then there is the convenience for the military personnel and their family members and the monetary savings.

[Altunin] However, letters to the editor are often received from military retirees and even from regular officers about how long they are standing in line for hospitalization....

[Chizh] Yes, that is true. In Moscow especially there are still not enough spots for everyone. Of course, I am not speaking about emergency care, where there are no problems, but rather about scheduled treatment. But as I already said before, this problem is already being solved. It is true that, as before, we are giving priority to veterans and invalids of the war and to categories related to them.

[Altunin] Ivan Mikhaylovich, the editorial staff also receives another type of letter—from military personnel or military family members suffering from an acute illness. They stubbornly ask to be sent abroad for treatment. What do you say to this?

[Chizh] We also receive such letters at the Main Military Medical Directorate. As a human being, I understand these people. A misfortune has occurred, and a person is rushing around....But I must say that the capabilities of our military medical institutions have increased significantly in recent times. At the Main Hospital imeni N.N. Burdenko, for example, more than 100 kidney transplants have been performed. Unique heart operations and laparoscopic operations (without cutting into the abdominal cavity) are being performed. At the Central Hospital imeni A.A. Vishnevskiy, aortocoronary shunting has been successfully performed in cases of ischemic heart disease and cardiostimulant implantation has been performed in cases of cardiac rhythm impairments. Transplantation of bone marrow to patients with oncologic diseases of the blood has been performed at the Military Medical Academy. The latest achievements in anesthesiology, resuscitation, microsurgery, etc., are being used increasingly widely in treatment practice.

As far as trips abroad for treatment is concerned, it is a deeply individual matter. But the corresponding articles are not stipulated in the Defense Ministry's expenditure estimates. I know that the Russian Federation Ministry of Health has very limited capabilities.

[Altunin] Afghanistan, where you saw both blood and death and directly organized medical care, the Chernobyl accident, the earthquake in Armenia, "hot spots" in different regions throughout the country—has all this "jolted" our military medicine? Has it all forced you to change anything?

[Chizh] Our medicine has the enormous experience of World War II, and we are continuing to study and use it. The recent events you mentioned have nevertheless forced us to reassess a great deal and put the emphasis on battlefield surgery. The main conclusion has been to create an emergency medicine service. In addition to a center, it calls for special-purpose medical detachments in the various Armed Forces and districts, as well as a series of special formations in military hospitals that are not part of the regular staff. There is experience. "Flying laboratories" have already been created at the Hospital imeni Burdenko: When the situation requires, a group of physicians and nurses are dispatched to "hot spots" on a small special aircraft to provide fast and efficient care to the wounded. Five medical "special calls" will be organized this year. All of this is in the normal channel of our overall doctrine—ensure a high level of battle readiness for actions in emergency situations.

[Altunin] As regards emergency situations, Ivan Mikhaylovich, you mentioned that the 10 people named by KRASNAYA ZVEZDA under the designation Postupka-93 [Deeds-93] included two military physicians.

[Chizh] How could I not mention it? Thank you. To remove a mine fuse from the body of a Georgian lad, which could have cost surgeon Colonel Shurenkov his own life, was of course a great deed....But I must say that nowadays selflessness is the rule rather than the exception among military physicians. During the attack on the 12th outpost of the Moscow frontier detachment, for example, Lieutenant Colonel Valeriy Sergeyevich Arutyunov, a novice physician of the 201st division, personally rushed onto an armored personnel carrier and, under Mojahedin fire, administered first aid to the wounded and carried them from the battlefield....And here is another very recent event: For 9 hours, Pavel Georgiyevich Bryusov, chief surgeon of the Armed Forces and major general of the medical service, stood at the operating table. He simultaneously removed the trachea and esophagus of a cancer patient and then used prostheses to restore them.

[Altunin] Several words about medical supply.

[Chizh] You know what the overall supply background in this country is like....The main problems stem from a lack of financing. With Ministry of Defense support, with help from the Ministry of Health, and by our own initiative, I can firmly announce that we have nevertheless succeeded in keeping our treatment and prophylactic institutions at a level that allows us to fully provide all types of medical care. We have reached more than 600 agreements to supply 7,000 different types of medical technology and

equipment from 700 enterprises and joint-stock companies for the sum of 20.8 billion rubles.

And we are allocating foreign exchange to purchase imported equipment, but very little. But I would like to say that we have organized the production of many domestic drugs and instruments of a quality on a par with and even superior to foreign analogues, such as ultrasound units, lithotriptors, gamma-cameras, and many other instruments.

[Altunin] It is well known that article 16 of the law "Concerning the Status of Military Personnel" is still "not in effect."

[Chizh] Several provisions related to medical care of all military personnel and their family members are already in effect, as I have already stated. But as far as payment of monetary compensation on the scale of the average schedule of duties is concerned, there is none as yet. Unfortunately, passage of this decree is being delayed on account of a lack of financial resources.

I would add that in connection with the fact that many military health resorts have "gone" to the CIS countries, above all to Ukraine. We are expanding the resort system in Russia. New buildings are going up in Podmoskovye and in the Stavropol and Krasnodar krays, and last year's plan was completed. In addition, a number of sanatoria have been acquired ("bought up") from other ministries that have fallen into decay. Such "deals" have been reached with the paratroopers [VDV], Transbaykal Military District [ZabVO], and military space forces, and talks are in progress with Ukraine regarding shared use of the Black Sea military health resorts.

[Altunin] One final question, Ivan Mikhaylovich. How do you, a doctor, serve as an example of fortifying one's health?

[Chizh] I still get by without medicine....I love volleyball and skiing. I must say that lately, because I have been too busy, I have abandoned these "procedures" and confined myself to intensive morning exercise. I think I will get into a new routine and make up for lost time....

Features of Parkinson Syndrome Induced Experimentally by a Deficit of Nigrostriatal Dopamine and Stimulation of the Caudate Nuclei Cholinergic Neurons

947C0260A Moscow ZHURNAL NEVROPATOLOGII I PSIKHIATRII IMENI S.S. KORSAKOVA in Russian Vol 93 No 6, Jun 93 (manuscript received 26 Jun 91) pp 3-7

[Article by G.N. Kryzhanovskiy, academician of the Russian Academy of Medical Sciences and director of the General Nervous System Pathology Laboratory, M.A. Atadzhanov, doctor of medical sciences and head of the Central Scientific Research Laboratory of Tashkent Advanced Physicians Training Institute, T.A. Voronina, professor and director of the Psychopharmacology Laboratory of the Pharmacology Scientific Research Institute of the Russian Academy of Medical Sciences, Moscow, and L.N. Nerobkova; UDC 616.858-008.6-092.9-092-7]

[Abstract] A study examined the distinctive features of Parkinson syndrome induced experimentally by a deficit of nigrostriatal dopamine and stimulation of caudate nuclei cholinergic nuclei. The experiments were performed on 172 nonpedigree male albino rats that were between 3 and 15 months old and that weighed 220 to 560 g each. In the first series of experiments, rats received intraperitoneal [IP] injections of 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine [MPTP] in doses of 20 to 40 mg/kg (depending on the animal's age) for 10 days. In the second series of experiments, rats received one-time injections of 1-methyl-4-phenyl-pyridine iodite bilaterally into the vicinity of the compact area of their substantia nigra in a dose of 10 µg in 2 µl of an isotonic sodium chloride solution at a rate of 1 µl/min. The control animals received the same volume of sodium iodite. In the third series of experiments, animals received one-time injections into the rostral compartments of both caudate nuclei of 5 µg of acetylcholine each in a volume of 1 µm together with 1 µg of proserine in a volume of 2 µl at a rate of 1 µl/min. The control animals in the series 3 experiments received the same volume of an isotonic sodium chloride solution. In the fourth series of experiments, animals received IP injections of oxotremorine in a dose of 1 mg/kg. The development of extrapyramidal disorders in the animals was studied, and electroencephalograms [EEGs] were recorded for all animals. Electrical activity was recorded in the sensorimotor cortex, caudate nuclei, ventrolateral nuclei of the thalami, substantia nigra, and globus pallidus. Chronic injection of MPTP into animals for 10 days was found to induce persistent Parkinson syndrome with oligo-, hypo-, and bradykinesia, protracted episodes of "freezing," and a lesser degree of rigidity and tremor. The distinctness of the manifestation and duration of extrapyramidal symptoms increased as a function of age of the animals; in animals aged 6-8 and 15-16 months, symptoms were observed at doses of the neurotoxin of 15-20 mg/kg. In younger animals, on the other hand, symptoms were observed at doses of 40-50 mg/kg. In some animals, brady- and oligokinesia persisted up to 3-4 weeks after the last injection of MPTP. All of the animals manifested vegetative-visceral impairments. Intranigral microinjection of 1-methyl-4-phenyl-pyridine iodite causes low-amplitude tremor of the head and forepaws that developed 1 hour after injection and persisted for 2-3 hours. Tremor was also observed after the administration of oxotremorine or acetylcholine with proserine more often than after the administration of MPTP or 1-methyl-4-phenyl-pyridine iodite. The tremor-rigidity form of Parkinson syndrome predominated in the "cholinergic" model, whereas the akinesia-rigid form predominated in the "dopamine deficit" model. Each of the two forms of Parkinson syndrome was hypothesized to have its own pathogenic mechanisms: Initiation of the syndrome was postulated to depend on formation of the generator of pathologically enhanced excitation and the caudate nuclei, which become the primary pathological determinant. The predominance of one or the other form of the syndrome was linked to the structures in which the secondary determinant formed and to which structures form the pathological system of the respective syndrome. Additional studies demonstrated that systemic injection of L-Dopa and other dopamine

agonists significantly suppressed generators of pathologically enhanced excitation in the caudate nuclei and resulted in attenuation of parkinsonian symptoms. In the "cholinergic" model, central choline blockers completely suppressed paroxysmal activity and resulted in attenuation or disappearance of tremor and rigidity. In the said model, both intracaudate injection of dopamine and systemic injection of dopamine agonists intensified tremor after injection of the drug and lengthened oligokinesia. Figures 4; references 23: 12 Russian, 11 Western.

Mechanism of Pathogenesis of Drug-Induced Parkinsonism (Experimental Biochemical and Bioelectric Investigation of the Effect of Haloperidol)

947C0260B Moscow ZHURNAL NEVROPATOLOGII I PSIKHIATRII IMENI S.S. KORSAKOVA in Russian Vol 93 No 6, Jun 93 (manuscript received 8 Oct 91) pp 15-18

[Article by Yu.L. Dovedova and N.S. Popova, Brain Scientific Research Institute, Russian Academy of Medical Sciences, Moscow; UDC 615.214.32:577.175.82 (0.15.4)612.822]

[Abstract] A study examined the biochemical and physiological mechanisms of motor impairments induced by long-term administration of haloperidol. Fifteen sexually mature Chinchilla rabbits weighing 2.5 to 3 kg each were studied in a biochemical experiment. Ten rabbits served as controls. The remaining five rabbits received daily intraperitoneal injections of haloperidol in a dose of 0.5 mg/kg body weight for 30 days. The rabbits were observed after the injections, and homogenates or subfractions of the synaptosomes and mitochondria of the sensorimotor region of their cortex and caudate nucleus isolated in a saccharose gradient (0.8 to 1.4 M) were studied. Next, physiological experiments were conducted on dogs that were injected with haloperidol in a dose of 0.3 mg/kg. The experiments were halted as bradykinesia developed (before day 30). Electrodes were implanted in all structures of the dogs' visual analyzer, in the motor region of their cortex, and in their caudate and adjacent nuclei. In the case of the rabbits, short-term (less than 10 days) administration of haloperidol resulted in activation of monoamine oxidase A and a decrease in the activity of monoamine oxidase B and acetylcholinesterase in the subfractions from the sensorimotor region of their brains. Significant increases in 5'-hydroxyindoleacetic acid and catecholamine content were found in the homogenates of both brain formations studied. Ten days after haloperidol administration had begun, the level of dopamine in the cortex increased more than 1.5 times, and that in the caudate nucleus more than doubled. These increases were correlated with decreases in monoamine oxidase B activity in the mitochondria of both the said formations by 35 and 18 percent, respectively, and by the respective doubling and tripling of noradrenaline levels. These findings indicated impairment of catecholaminergic mediation as a result of haloperidol administration. The reciprocal change in activity of monoamine oxidase A and B and content of biogenic amines was taken as evidence of the very same interaction of the monoaminergic systems as a whole. The behavioral observations and bioelectric data regarding induced potentials in the dog brains did not reveal any significant changes after 3 to 10 of haloperidol administration. From day 10 onward (to the 3rd week), maintenance of a higher level of catecholamines in the brain tissue in the experimental animals than in the controls was evident: The cortex of the experimental animals contained twice as much dopamine and six times as much noradrenaline than that of the control animals, and the caudate nucleus of the experimental animals contained 7.5 times more dopamine and 7 times more noradrenaline than that of the controls. Serotonin levels remained virtually unchanged in the experimental animals despite elevations in monoamine oxidase A activity and the amount of 5'-hydroxyindoleacetic acid in the caudate nucleus. The physiological studies established that 3 weeks of haloperidol administration resulted in similar alterations in induced potentials in II of the subcortical structures of the animals' brains. These alterations were deemed a consequence of limited use of movement-induced afferentation. At the behavioral level, no clear symptoms of bradykinesia were observed. Twenty to 30 days of haloperidol administration was found to result in an increase in monoamine oxidase B and a decrease in acetylcholinesterase activity in subfractions of the cortex and caudate nucleus coupled with a maintenance of elevated monoamine oxidase A activity. At the same time, a 50 percent decrease (compared with that in the controls) in dopamine levels in the cortex and a drop in dopamine levels in the caudate nucleus practically to zero were observed in the experimental animals. At the same time, the experimental animals' noradrenaline level did not drop below normal, and the amount of serotonin in their cortex increased. It was concluded that long-term use of haloperidol results in an imbalance of the neuromediator systems and in an alteration of synaptic transfer processes that are reflected in cortical-subcortical interrelationships in the brain and accompanied by extrapyramidal impairments. Figures 3; references 19: 11 Russian, 8 Western.

Cardiointervalography Screening of Nervous System in Children from Radionuclide Contaminated Rayons

947C0285B Minsk ZDRAVOOKHRANENIYE BELORUSSII in Russian No 2, Feb 94 (manuscript received 09 Jun 93) pp 30-33

[Article by V. V. Nedvetskaya and S. A. Lyalikov, Pediatrics Chair, Therapy Department, Grodno Medical Institute; UDC 616.839- 953.2:612.014.482]-073.96

[Abstract] The factors regulating circulatory system function were studied in children aged 6-17 years to better understand the etiology and mechanism of the development of disturbances in the cardiovascular system and to develop better therapeutic and prophylactic measures. The control group consisted of 1291 children from rayons with Cs^{137} soil contamination of less than 1 Ci/km^2. The experimental group consisted of 177 children from rayons with Cs^{137} soil contamination of more than 15 Ci/km^2. Cardiointervalography employed to assess the vegetative status revealed that teenage girls in the experimental group were much more likely to exhibit an increase in systolic pressure, while teenage boys exhibited an increase in

diastolic pressure. The average pulse rate was also higher among teenagers in the experimental cohort. The data showed that children residing in areas with elevated levels of radionuclide contamination present with a number of differences in sympathetic regulation that are associated with the extent of contamination. In conclusion, the effects of radioactive contamination are more pronounced in girls. In addition, it is suggested that arterial dystonia in teenagers from contaminated areas is associated with disturbances in vegetative regulation identified during the course of investigation. Tables 2; references 4 (Russian).

Short-Term Cardiac Rhythm Monitoring of Residents of Radionuclide Contaminated Areas

947C0285C Minsk ZDRAVOOKHRANENIYE BELORUSSII in Russian No 2, Feb 94 (manuscript received 07 May 93) pp 33-35

[Article by T. V. Krushevskaya, L. A. Nizovtsova, V. N. Gayduk, V. v. Chaykovskiy, Cardiology Research Institute, Belarus Ministry of Health; UDC 612.172.2-07:612.014.482

[Abstract] An original technique of short-term (10 min) monitoring of cardiac rhythm with a novel cardiology microanalyzer was employed to screen 252 residents of Narovlya, where the Cs^{137} level is 18.96 Ci/km^2, and 125 residents of Minsk (control). The microcardioanalyzer records the pulse, single and multiple extrasystoles, R/T extrasystoles, and asystole lasting more than 2 seconds in a real time scale. Comparison of microanalyzer results with results of conventional screening methods showed the microcardioanalyzer results were 75 percent reliable. Results of testing the microcardioanalyzer indicated no significant differences in arrhythmia frequency using either clinical EKG data or short term monitoring. While arrhythmia was found in 6.4 percent of the control group and 3.5 percent of the experimental group, this difference is not statistically significant. Further improvement of the monitoring technique and clinical experience are necessary to determine whether the microcardioanalyzer can be used in actual situations. Tables 1; references 5 (Russian).

Morbidity in Children, From Areas Contaminated by Radionuclides, With Chronic Forms of Pathology

947C0290 Moscow VOPROSY KURORTOLOGII, FIZIOTERAPII I LECHEBNIY FIZICHESKOY KULTURY, in Russian, No 6, Nov-Dec 93, pp 46-48

[Article by E.B. Borovik, G.M. Baran ova and T.N. Fursova, RNTs of Rehabilitation and Physical Therapy, Moscow; UDC 616-053.2-036.12-02:614.876]:313.13]

[Abstract] A study of the level and structure of morbidity of children living in areas of Russia contaminated by radionuclides and having chronic forms of pathology was conducted in order to develop a concept of sanatorium and health resort rehabilitation of such children. The study, conducted to provide scientific information concerning this problem, considered data concernin g the number of patients and the number of persons visiting health clinics in 15 regions contaminated by radionuclides and persons in uncontaminated areas. Analysis of materials of prophylactic examinations of 933,592 children, ranging in age from 1 to 14 years, from four regions of Russia (Tula, Bryansk, Orlovsky and Ryazan') contaminated by radionuclides included 85.6 percent of the children of these oblasts. Tables showing the level of chronic morbidity among children in the regions of Russia s tudied in 1988-1991 and the rate of increase of the number of patients in these regions with chronic diseases were presented and discussed. Diseases investigated included: neoplasms, endocrine system diseases, diseases of the blood and hemopoietic organs, diseases of the nervous system, the sense organs and the circulatory system, respiratory diseases, digestive diseases, diseases of the urogenital system, the skin and subcutaneous fatty cellular tissue, diseases of the skeletal-muscular system and congenital anomalies. The study showed that, in the areas contaminated by radionuclides, the rate of increase of chronic diseases among the children populations was reliably higher than that in uncontaminated regions and than in Russia as a whole. There was a tendency to a more significant increase of diseases of the endocrine system, diseases of the blood and hemopoietic system, diseases of the skin and congenital anomalies. These findings require further confirmation. The number of neoplasms, disease of the nervous system and sense organs, diseases of the organs of digestion, and of the skeletal-muscular system increased for the Russian Federation as a whole, during the period studied. The frequency of chronic and relapsing respiratory diseases tended to decrease in many of the regions of Russia studied, except in Tula and Penza oblasts, where they increased. The system of sanitation and the sanitorium and health resort rehabilitation of children of Chernobyl must be scientifically validated.

PHARMACOLOGY AND PHYSIOLOGY

Study of the Structure/Antiesterase Activity Relationship in a Series of O-Phosphorylated Oximes. 1. Methylphosphonates

947C0354 Moscow KHIMIKO-FARMATSEVTICHESKIY ZHURNAL in Russian Vol 28 No 6, Jun 94 [manuscript submitted 2 Mar 93] pp 6-9

[Article by G. F. Makhayeva, V. V. Malygin, Sh. M. Yakubov, S. M. Garbunov, Institute of Physiologically Active Substances, Russian Academy of Sciences, Chernogolovka, Moscow Oblast; UDC 547.26'118: 577.152.311.042: 541.697+519.237.5]

[Abstract] Organophosphorus compounds are physiologically active substances that are used in medicine and in agriculture. The primary biotarget of the compounds is acetylcholinesterase. At the pharmacokinetic stage, organophosphorus compounds bind with structurally similar esterases. The work reported here consists of a regression analysis of acetylcholinesterase, butyrylcholinesterase, and carboxylesterase inhibition with the O-phosphorylated oximes $R_1O(CN_3)P(O)ONCCIR_2$. The researchers found that the oxime fragment participates in the polar interactions when the molecules of the inhibitor bind in the active centers of the esterases. The inhibition activity of the

compounds correlates with the degree of electroacceptor properties of the oxime substituents represented by the Swain and Lapton constants. Figures 1, references 17: 7 Russian, 10 Western.

Target Speed Discrimination by Dolphin Echolocatory System

947C0355A Moscow SENSORNYYE SISTEMY in Russian Vol 8 No 2, Apr-Jun 94 (manuscript received 07 May 93) pp 25-33

[Article by K.A. Zaytseva, and V.I. Korolev, Institute of Evolutionary Physiology and Biochemistry imeni I.M. Sechenov, Russian Academy of Sciences, St. Petersburg; UDC681.883]

[Abstract] Black Sea dolphins (Tursiops truncatus) were employed in motor conditioned reflex studies with food reinforcement to assess efficiency of the echolocatory mechanism in target speed discrimination. The key observation was that the accuracy vs. speed plots yielded a linear relationship with a positive slope in the 1.8 to 3.2 cm/sec range. V = 2.6 cm/sec constituted the threshold speed for 75% accuracy in speed determination, with 100% accuracy evident at > 3.2 cm/sec. The question of whether dolphins utilize a Doppler-type sonar mechanism in target speed discrimination remains open. Figures 4; references 10: 7 Russian, 3 Western.

Computational Functions of Complex Striate Cortical Neurons: Mathematical Modeling

947C0355B Moscow SENSORNYYE SISTEMY in Russian Vol 8 No 2, Apr-Jun 94 (manuscript received 23 Aug 93) pp 72-78

[Article by Yu.D. Kropotov, V.Ye. Semenov and I.Z. Kremen, Institute of the Human Brain, Russian Academy of Medical Sciences, St. Petersburg; UDC612.821.8]

[Abstract] Mathematical modeling was applied to the computational function of the complex striate cortical neuronal lattice previously described [Kropotov, YuD, et al., Sensor. Sistemy, 2(4):390-399, 1988]. The study was based on two fundamental assumptions. The first that the response of a complex neuron is invariant relative to the spatial phase of the Fourier component or the Gabor function of the stimulus. The seond that the diameter of the receptive fields of the complex neurons are twice as great as those of simple neurons with identical eccentricity. The results were interpreted to support the conclusion that with sinusoidal input signals responsiveness of the complex neurons varies with the spatial frequency of the signal. In addition, the findings confirmed the assumption that the response is invariant with respect to its spatial phase of the singal. These findings provide further support for the hypothesis that the striate cortex is involved in texture perception and discrimination. Figures 2; tables 1; references 11: 2 Russian, 9 Western.

Natural Restrictions on Solutions of 'Shape From Shading' Problems: Analysis of Psychophysiological Experiments

947C0355C Moscow SENSORNYYE SISTEMY in Russian Vol 8 No 2, Apr-Jun 94 (manuscript received 20 Oct 93) pp 87-95

[Article by A.A. Prusakov, Institute of Information Technologies, 'Kurchatov Institute' Russian Scientific Center, Moscow; UDC612.84]

[Abstract] Psychophysiological studies have shown that the human visual system can perceive 3-D shape from shading without information on illumination and curvature. Current evidence indicates that perceptions of 3-D shapes seem to be based on slight changes in halftones and orientation of various surface elements relative to the direction of illumination. Application of the image irradiance equation to human experimental data and analysis of the results implies that the human visual system employs such algorithms for image analysis in terms of surface topography. References 12: 3 Russian, 9 Western.

Role of Invertors in Mechanism of Regulation of Heart Function

947C0286A Moscow BYULLETEN EKSPERIMENTALNOY BIOLOGII I MEDITSINY in Russian No 2, Feb 93 (manuscript received 6 Oct 92) pp 115-117

[Article by V.V. Frolkis, academician of Ukraine Academy of Sciences, and V.L. Matrenitskiy, Physiology Laboratory (head, V.V. Frolkis), Gerontology Scientific Research Institute, Ukraine Ministry of Health, Kiev; UDC 616.12-008.3-07:616.127-018.1-008.9]

[Abstract] The plasmatic membrane of myocardiocytes and its transport and receptor function largely determine the heart's contraction and rhythm activity. In the past several years, researchers have established that regulators of the state of the plasmatic membrane known as invertors are synthesized in cells under genome control and that invertors can activate Na^+, K^+, and adenosine triphosphatase (ATPase) of plasmatic membranes, open K^+ channels, and induce hyperpolarization of the plasmatic membrane. A study examined the possible involvement of invertors in regulating heart function. The studies were performed on certified white male rats between the ages of 6 and 10 months. Coronary perfusion was performed according to the Langendorf method under constant pressure, and the following were studied: heart rate, mechanical force of the myocardium, maximum pressure developed by the myocardium, and myocardial pressure rate and time indicators. The activity of adenylate cyclase was determined in the cardiac plasmatic membranes in an acellular system by using an incubation medium of Tris-HCl (0.05 M), EDTA (0.001 M), dithiothreitol (0.001 M), theophylline (0.005 M), ATP (0.001 M), KCl (0.01 M)), and MgCl (0.005 M) at pH 7.5 at 37°C. Creatine phosphate (0.02 M) and creatine phosphokinase (1 mg/ml) were used as an ATP regeneration system. The enzyme's activity was judged by the increase in cAMP. During the 2-hour course of heart perfusion there was a significant deterioration in cardiac function manifested in a reduced heart rate,

decrease in the force and rate of heart contraction, increase in the time required to reach maximum myocardial pressure, decrease in the coronary duct, and significant depression in the T wave on the ECG recorded from the posterolateral wall of the left ventricle. Intraperitoneal injection of actinomycin D (50 mg/kg) into the rats 40 minutes before isolation of their heart resulted in a moderate decrease in starting P_{max} indicators in comparison with controls, and actinomycin D noticeably stabilized cardiac function (both cardiac rhythm and contractions) and adenylate cyclase activity. Studies of the adenylate cyclase system of the myocardium before and after perfusion established that the impairment in heart function that develops during 120 minutes of perfusion is accompanied by a change in status of the adenylate cyclase complex: After 120 minutes of perfusion, the cAMP level and basal activity of adenylate cyclase remained virtually unchanged, whereas adreno- and fluoride-stimulated adenylate cyclase activity decreased. A separate series of experiments established that in and of itself, actinomycin D in vitro in an acellular system does not affect the basal or stimulated activity of adenylate cyclase. When injected into intact animal heart membranes, cytosol from the cells of a heart that had been perfused for 120 minutes decreased the adrenosensitivity of the intact hearts' adenylate cyclase. Actinomycin D prevented this effect. The experiments were taken as proof of the fact that the cytosol of the myocytes of a heart perfused for an extended period contain factors inhibiting adrenoreactivity of the heart as a result of suppression of the sensitivity of adenylate cyclase to adrenaline and that the fact that synthesis of the said regulators is inhibited by actinomycin D confirms their protein (peptide) nature. The said factors were thus classified as invertors (i.e., cellular regulators transmitting control signals from genome to nucleus). Figure 1; references 7 (Russian).

Serotonin-Producing Cells in Periods of Normothermia and Hypothermia

947C0286B Moscow BYULLETEN EKSPERIMENTALNOY BIOLOGII I MEDITSINY in Russian No 2, Feb 93 (manuscript received 21 Aug 92) pp 119-122

[Article by L.V. Shestopalova, M.S. Vinogradova, O.N. Ponomareva, and Ye.V. Dubinin, Physiology Department (head, L.N. Ivanova, corresponding member, Russian Academy of Sciences), Novosibirsk State University; UDC 591.434:599.32]

[Abstract] Even though the gastrointestinal tract of hibernating animals is completely cut off from its main function (i.e., digesting food) during hibernation, it still continues to function as an endocrine organ supplying the body with necessary hormones and biologically active substances such as the biogenic amine serotonin (5-hydroxytryptamine). The structural organization and functioning of serotonin-producing cells of the duodenum of the hibernating red-necked ground squirrel (*Citellus erytrogenys* Brandt) was studied in summer while the animals were fully awake, in winter while they were in states of protracted hypothermia (generally lasting 12-18 days), and when in brief states of normothermia (during periods when they awoke spontaneously and remained awake for 18-24 hours). The animals studied in summer were decapitated when their body temperature was at 37°C. Of the animals studied in winter, those killed while in a state of deep torpor had a body temperature of 5-6°C, and those killed during periods of spontaneous awakening had body temperatures of 34-36°C. Samples of the animals' duodena were fixed with 3 percent glutaric aldehyde and 1 percent osmic acid and studied under a JEM-100 CX electron microscope. The duodenal tissue was subjected to morphometric analysis in an open test system with a small increment (d = 0.36 μm) at a final magnification of 55,000*x*. The duodenal tissue removed from both the ground squirrels killed in summer and those killed in winter after spontaneously awakening contained 30.6 +/- 2.9 serotonin-producing cells per 1,000 epithelial cells versus only 21.7 +/- 3.3 per 1,000 epithelial cells in the animals killed while in deep hibernation. The cells extracted from the torpid animals manifested the following indications of an inhibition of synthetic processes: The endoplasmic network was fragmented, the number of attached ribosomes was decreased, the number of free ribosomes was increased, polysomal formations were rarely encountered, and the plate complex cisterns were shortened and assumed a vacuolar structure. The serotonin-producing cells taken from the duodena of the ground squirrels killed while awake in winter were similar to those taken from the animals killed in summer in that their cytoplasm contained large amounts of polysomes and ribosomes, their granular endoplasmic reticulum was most often long, their Golgi apparatus appeared active, and their patterns of granule formation were similar to those of the cells of the animals killed in summer. The cells of the animals killed while awake had similar levels of protein synthesis activity, whereas those of the animals killed while in deep torpor were not found to be synthesizing proteins but rather to be releasing accumulated material: The number of dissolved granules in the cells of the animals killed in winter amounted to 57.6 percent versus 29.6 percent for the animals killed in summer and 34.2 percent for the animals killed in winter after spontaneously awakening. The similarities in the ultrastructure and functioning of the serotonin-producing cells of animals killed while awake (regardless of the time of year when they were killed) and the significant differences detected between the said cells and those taken from animals killed while in a state of deep torpor were taken as confirmation of the fact that serotonin-producing cells are an important element in the regulation of hibernation. Figures 3, table 1; references 14: 9 Russian, 5 Western.

Development of Superresistance to Hypoxic Hypoxia Under the Effect of Adaptation to Short-Term Stress Exposure

947C0286C Moscow BYULLETEN EKSPERIMENTALNOY BIOLOGII I MEDITSINY in Russian No 2, Feb 93 (manuscript received 7 Jul 93) pp 132-135

[Article by F.Z. Meyerzon, T.D. Minyaylenko, and V.P. Pozharov, General Pathology and Pathological Physiology Scientific Research Institute, Moscow, and Physiology

Institute imeni A.A. Bogomolets, Ukraine Academy of Sciences, Kiev; UDC 616-008.922.1-008.6-092: 612.017.4]

[Abstract] A study examined the effect of adaptation to repeated noninjurious immobilization stress on the resistance of male Wistar rats (each weighing 150 to 220 g) to hypoxic hypoxia. Twenty control rats and 20 experimental rats were kept under laboratory conditions for 24 hours and then subjected to the effects of acute hypoxic hypoxia that was induced by having them inhale a gas mixture containing 6 percent O_2 for 2 hours. Before being forced to inhale the gas mixture, the animals in the experimental group were adapted to stress for 24 days by fixing their four extremities to their backs for 15 minutes on day 1 and 30 minutes on subsequent days. The controls were not subjected to any such form of stress. Throughout the experiment, the effect of adaptation on the animals' survival rate and the main factors affecting the survival rate under conditions of acute hypoxia were evaluated. The experiment confirmed that adaptation of animals to regularly repeated stress sharply increases their resistance to acute hypoxia. Sixty-five percent of the animals not subjected to preliminary adaptation to stress died after breathing a gas mixture containing 6 percent O_2 for 120 minutes. Among those animals subjected to adaptation, the death rate after inhaling the 6 percent O_2 mixture for 120 minutes decreased to just 10 percent. Data regarding the experimental and control animals' patterns of respiration were analyzed to determine the reason for the protective cross-effect of adaptation. The adapted animals were found to be capable of more efficient mobilization of respiratory and circulatory function, their tissues were significantly more capable of using O_2 from the blood, and acidosis and the cell membrane-damaging processes that develop during hypoxia (specifically lipolysis and lipid oxidation) were significantly restricted in their bodies as compared with similar processes in the animals subjected to immobilization stress. The main factor in the improved survival rate of the adapted animals, i.e., the increased ability of their tissues to use blood O_2, was attributed to at least two factors: (1) the capillary-cell membrane barrier, and hence the higher diffusion of O_2 through it, were better maintained in the adapted animals than in the controls, and (2) mitochondria-level processes of O_2 utilization and oxidation phosphorylation are better maintained in adapted animals than in controls. Figures 4; references 10: 3 Russian, 7 Western.

Sesquiterpene Lactone Azerin Has Memory-Boosting Properties

947C0286D Moscow BYULLETEN EKSPERIMENTALNOY BIOLOGII I MEDITSINY in Russian No 2, Feb 93 (manuscript received 13 Oct 92) pp 166-167

[Article by E.M. Melikov, S.V. Serkerov, G.D. Movsumov, and N.F. Mir-Babayev, Neurobiology of Cognitive Behavior Laboratory (head, E.M. Melikov, doctor of biological sciences), Physiology Institute imeni A.I. Karayev, Azerbaijan Academy of Sciences, Baku; UDC 616.89-008.464-085.322-036.8-07]

[Abstract] Azerin is a sesquiterpene lactone with the empirical formula $C_{20}H_{24}O_5$ that was isolated from the plant genus *Ferula* at the Botany Institute of the Azerbaijan Academy of Sciences. A study examined the effect of Azerin on the preservation and formation of traces of memory of a passive avoidance response developed during short-term training. Azerin's memory-boosting properties were compared with those of the nootropic drug Nootropyl (piracetam) in studies performed on 70 nonpedigree male rats weighing 250 to 300 g each. All were subjected to short-term training as reported elsewhere to teach them to passively avoid darkness. The animals were divided into three groups. The first two groups consisted of two control subgroups (of 10 and 11 rats) and two experimental subgroups (10 and 11 rats). The third group consisted of one control group (10 rats) and two experimental groups (10 and 8 rats). Nootropyl and Azerin were dissolved in olive oil and administered orally to the rats in doses of 100 mg/kg for 4 days, ending on the day of passive avoidance response training. The control rats received pure olive oil in the same dose regimen. Immediately after the passive avoidance response training, the animals in the first two groups were returned to their "home" cages. The group 3 animals received electroshock treatment with a current of 20 mA lasting 500 ms, after which they were returned to their "home" cages. The rats' memory of the passive avoidance response training was tested in a 900-second test administered 24 hours after training and every 48 hours thereafter. Preliminary experiments had already confirmed that neither Nootropyl nor Azerin altered rats' congenital instinct to prefer dark places to illuminated places. The rats that had received the Nootropyl maintained their passive avoidance response for up to 5 to 7 days, the animals in the control group lost all memory of their training after only 2 to 3 days, and the animals that had received Azerin continued to avoid darkness for 17 to 19 days. Among the rats subjected to electroshock, retrograde amnesia developed after 24 hours in 100 percent of the animals administered placebo versus 63 percent of those receiving Nootropyl and only 20 percent of those receiving Azerin. It was hypothesized that Azerin's good memory-boosting and antiamnestic properties are due to its ability (inherent to all sesquiterpene lactones) to increase cAMP levels and induce solubilization of membrane proteins into the cytoplasm of cells by binding with the proteins' SH-groups. Figures 2, tables 2; references 11: 5 Russian, 6 Western.

Characteristics of Antilysozyme Activity of *Staphylococcus aureus* During Different Types of Courses of Experimental Infection

947C0286E Moscow BYULLETEN EKSPERIMENTALNOY BIOLOGII I MEDITSINY in Russian No 2, Feb 93 (manuscript received 7 Oct 92) pp 178-180

[Article by O.V. Bukharin, B.Ya. Usvyatsov, and N.V. Sheyenkov, Microorganism Persistence Department (head, O.V. Bukharin, corresponding member of the Russian Academy of Natural Sciences), IEGM (expansion not given), Ural Department, Russian Academy of Sciences, Orenburg; UDC 616.98:579.861.2]-092.9-036.1]

[Abstract] The antilysozyme activity of *Staphylococcus aureus* during the development of acute and protracted

forms of experimentally induced infection was estimated. Strain No 162 of *Staphylococcus aureus* isolated from the nose of a resident bacteria carrier was cloned. Isogenous clones with different levels of antilysozyme activity (from 0 to 4 μg) were produced and used to infect female CBA x C57B1/6 mice via intraorbital injections into their eyes. At different times during the study (from day 1 to 48) the rats' kidneys were excised, homogenized, and cultured with a standard loop on agar to determine their microbial dissemination (colony-forming units/mg kidney tissue). Antilysozyme activity was determined by the method of Bukharin et al., and the identity of the isolated cultures was established on the basis of phagotype profile. Population analysis was performed by studying antilysozyme activity in 36 subpopulations isolated from 6 mice every day of the study. A link was discovered between time of isolation of the staphylococci from the kidneys and the level of antilysozyme activity possessed by the clones. The attenuating type of infection developed in mice infected with clones having a low antilysozyme activity. In the structure of the said population, there was a move toward increased uniformity from the standpoint of antilysozyme activity in the final state of the infection process. The only colonies that were preserved were ones with no or low antilysozyme activity. The protracted form of infection, on the other hand, was caused by a clone with high antilysozyme activity. The dynamics of its microbial dissemination were characterized as infraradian and rhythmic. Its population structure was characterized by maintenance of a high degree of nonuniformity from the standpoint of antilysozyme activity and by selection of colonies with high antilysozyme activity. The experiments established that the antilysozyme activity of staphylococci is a significant link in the pathogenesis of the phenomenon of persistence and that it determines survival time of the causative agent in the body. The research results were said to be useful in developing new methods of predicting the formation of staphylococcal carriage. Figures 3; references 13: 11 Russian, 2 Western.

Antihistone Activity of Bacteria

947C0286F Moscow BYULLETEN EKSPERIMENTALNOY BIOLOGII I MEDITSINY in Russian No 2, Feb 93 (manuscript received 25 Sep 92) pp 180-183

[Article by V.Yu. Sokolov, Microorganism Persistence Department (head, Prof. O.V. Bukharin, corresponding member of the Russian Academy of Natural Sciences, Ecology and Genetics of Microorganisms Institute, Ural Department, Russian Academy of Sciences, Orenburg; UDC 576.809.7:576.315.4]

[Abstract] Histones, the main nuclear proteins of all eukaryotic organisms, play a very important role in the structural organization of chromatin and chromatin-related gene expression and activation. The finding that histones are located in the heart of the DNA spiral has bolstered the idea that bactericidal activity is characteristic of exogenous histones and uncharacteristic of histones in situ. A study examined the antihistone activity of bacteria and related infection of the cell nucleus in humans. Epitheliocytes were collected by cotton swab from the mucous membranes of 100 schoolchildren, placed in medium 199, and transported a laboratory where they were subjected to bacteriologic and cytoscopic analysis. The isolated bacterial strains were identified, and their antihistone activity was determined through a procedure that involved culturing them on the surface of 1.5 percent plain agar containing histones in concentrations of 0.8 to 8 mg/ml in 0.4-mg/ml increments, incubating them at 37°C for 20-24 hours, inactivating the strains with chloroform vapors for 20 minutes, coating the inactivated cultures with a a second layer of nutrient medium that contained a suspension of *Bacillus cereus* test culture, incubating the cultures for an additional 16 to 24 hours, and determining their antihistone activity based on the presence of growth of the test culture around the colonies of the culture being studied. An accelerated version of the procedure that made it possible to cut the analysis time by 1 day was also used. The cytoscopic studies were conducted by fixing the epitheliocytes on a glass slide with methyl alcohol for 5 minutes and then dying them. A total of 125 cultures were identified during the bacteriologic analysis, including bacteria of the genera *Micrococcus, Neisseria, Staphylococcus, Corynebacterium,* and *Actinetobacter.* The frequency of antihistone activity among the strains of the species *C. pseudotuberculosis, M. luteus, N. sicca, N. lentus,* and *S. warneri* was nearly 100 percent, and it was in these strains that antihistone activity was at its highest. Among the strains of the species *A. calcoaceticus, S. hominus, S. epidermis, S. xylosus,* and *S. aureus,* antihistone activity was encountered less frequently or not at all, and the level of antihistone activity was much lower than that of the bacteria in the aforesaid group. These conclusions regarding the antihistone activity of bacteria do not fully fit in with existing ideas regarding the taxonomic distribution of pathogenic properties among microorganisms, and additional in-depth research is needed to explain the biological role of this new property of bacteria. Figures 2, table 1; references 8: 4 Russian, 4 Western.

Effect of Low-Intensity Laser Radiation on Rat Brain Capillaries

947C0286G Moscow BYULLETEN EKSPERIMENTALNOY BIOLOGII I MEDITSINY in Russian No 2, Feb 93 (manuscript received 26 May 91) pp 219-221

[Article by V.M. Chertok and D.V. Bykov, Human Anatomy Department (head, Prof. V.M. Chertok), Vladivostok Medical Institute; UDC 591.415:591.481.1:615.849.19]

[Abstract] The effect of laser radiation on the brain's capillaries was studied on 34 sexually mature white rats weighing 170 to 180 g each. A GNL-108 helium-neon laser (wavelength, 632.8 nm; power flow density, 0.76 mW/cm^2) was used to irradiate the right parietal region of the rats' brains for 0.5, 1.5, 15, and 30 minutes and 1 and 3 hours.

A group of similarly aged and sized rats that was not subjected to irradiation served as controls. The irradiated rats were killed, decapitated, and their capillary beds prepared for study by using magnesium-activated adenosine triphosphatase [ATPase]. The capillaries in the parietal region of the brains of the nonirradiated rats were found to be thin, straight, curved or slightly twisted little tubes that were arranged relatively evenly in the projection of the tissue section. The density of deposition of histochemical reaction product in the capillary walls was nonuniform. In some sections of the capillaries it was deposited less densely, coloring the vessels a yellowish brown or yellow, whereas in other areas of high enzyme activity, the capillaries took on a dark brown, almost black color. The highest amounts were in brown microvessels with moderate ATPase activity. The capillary beds of the irradiated rats exhibited a dose-dependent effect of low-intensity He-Ne radiation. Irradiation lasting 0.5 minutes induced an increase in the number of microvessels with a high density of reaction product deposition: The average values of capillary bed enzyme activity in the said group of rats were more than a third higher than average levels in the control group. In addition, the total length of the capillary bed in the group of rats irradiated for up to 15 minutes increased by 9.6 percent. An 8-10 percent decrease in average values of ATPase activity in the capillary bed of rats irradiated for 5 to 30 minutes was observed. The said rats' capillaries assumed a twisted and sometimes spiraled appearance. Continuous irradiation for 1 to 3 hours, on the other hand, induced a pronounced curtailment of ATPase activity, and most of the capillaries were found to have sparse deposits of precipitate. Total capillary length peaked after 15 minutes of irradiation and then began to decrease; however, only after 3 hours of irradiation did it become significantly less than the control length. The experiments thus confirmed the high sensitivity of the capillary bed of the rat cerebral cortex to the effects of low-intensity laser radiation. Figure 1, table 1; references 7: 5 Russian, 2 Western.

Dopamine and Complamin Impact on Central Hemodynamics and Microcirculation in Children with Pyoinflammatory Diseases

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[Article by V. N. Arinchin, V. V. Kurek, A. I. Sevkovskiy, Ye. Yu. Protsenko, Pediatric Homeostasis and Pyoinfection Laboratory, Minsk Medical Institute; UDC 617-002.3-053.2-02:615.281]

[Abstract] The cardiovascular system was studied in 88 children aged 5-13 years with acute complicated pneumonia and widespread suppurative peritonitis. All were in critical condition, with some displaying clinical signs of circulatory failure. Dopamine was administered to 42 patients, most of whom suffered from widespread peritonitis, in a dose of 3 μg/kg per minute for 15 minutes. Complamin was administered to 46 patients, most of whom suffered from pneumonia, in a dose of 5 mg/kg per minute for 15 minutes. In one-third of the children (those with marked hyperdynamics) complamin did not evoke any significant changes in central hemodynamics. However, regardless of the initial hemodynamics, complamin increased the effectiveness of tissue perfusion by increasing the number of functioning capillaries. In addition, complamin was most effective in children with decreased cardiac output due to excess peripheral resistance. Dopamine was shown to be most effective in children with cardiac failure, because it increased cardiac output and decreased peripheral vascular resistance. However, study of microcirculation in the fingers revealed that dopamine in virtually all cases decreased the effectiveness of tissue perfusion in the skin and muscles in favor of splanchnic circulation. Figures 1; tables 2; references 7: 5 Russian, 2 Western.

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